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ABSTRACT

This publication contains the text of papers given at a conference of science teachers and professional scientists organized by the Canadian Teacher's Federation. Papers are entitled "Science Education and the Nation's Needs," "Science in the Elementary School," "Science for All, or the Purposes of New Courses," "The New Secondary School Courses," "Principles, Purposes, and Problems of the New Secondary School Science Courses," "Interesting the General Student in Science," "Science Outside the Curriculum - Fostering Excellence," "Encouraging the Future Scientist," "The Pre-Service Education of the Science Teacher," "Remarks on the Pre-Service Education of Science Teachers," "The Education of the Science Teacher," and "The In-Service Education of the Science Teacher," (EB)

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FEDERATION

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## THE 1966 CONFERENCE ON

# SCIENCE and the TEACHER

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# SCIENCE AND THE TEACHER

**Papers Delivered at the 1966 CTF Conference on Science Teaching**
**Held at the Chateau Laurier Hotel, Ottawa**
**March 3-5, 1966**

Canadian Teachers' Federation
444 MacLaren Street Ottawa 4, Ontario

## PREFACE

In March 1966, representatives of science specialist groups associated with the affiliates of CTF, and delegates of several of the affiliates themselves, met along with representatives of several national associations with a professional interest in science, at a conference organized by the Canadian Teachers' Federation. The main purpose of the conference was to afford an opportunity for communication among science teachers in the various provinces, and between science teachers on the one hand and professional scientists on the other. The program was designed to suggest the kind of topic which might fruitfully be examined in later joint conferences, and in relation to which some continuing form of liaison would be of mutual benefit.

This publication contains the text of papers given at that Conference.

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# SCIENCE EDUCATION AND THE NATION'S NEEDS

by

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We live in an age of science and technology in which no nation can hope to achieve or maintain a position of leadership without the fullest development of its scientific potential. Probably the most important component of Canada's scientific potential is the calibre of the program for scientific education. The best scientific education involves not only time, but able students, skilled and dedicated teachers, the best and most modern materials with which to teach, and learning opportunities for the gifted student beyond those found in the usual classroom courses.

Curricula and courses in mathematics and science in elementary and secondary schools have, until recently, failed to evolve at a pace commensurate with the rapid growth of scientific and technological knowledge. In part the lag has been due to the volume of new knowledge and the accelerating pace of discovery in science. To some extent it is also attributable to the gulf which has developed between research scientists primarily concerned with the acquisition of new knowledge and teachers, writers, school administrators and others primarily concerned with the diffusion of knowledge. This has resulted in a low level of scientific literacy among citizens at a time when the public is increasingly confronted with a need for scientific knowledge, the loss of many potential scientists, mathematicians and engineers and a serious waste of time in the preparation of those students who do pursue science courses in universities.

Courses in science in the secondary schools should be constructed so that time is provided for the consideration of important principles, and topics should be chosen so that they form a coherent system of learning. Students should be taught the processes of science as well as what may be called science content. Some time should be spent toward developing fundamental skills required in scientific activities. The performances in which these skills are applied involve objects and events of the natural world and in doing so require information from various sciences as they proceed. It is not only necessary to accumulate knowledge about any particular subject such as physics, biology or chemistry but also to ensure competence in the use of processes that are basic to all science. It has been a common mistake to underestimate the learning capacity of young students. They always have much more potential than you think but are rarely likely to admit it unless they are pressed or drawn out.

From an early age the teacher should give the student a perspective of what kind of knowledge is necessary to enable a person to design a bridge, a computer, a radar station, for a chemist to evolve a new material, for medical research to create a new drug, or for agricultural research to evolve a new species of wheat. If teachers do not have this kind of perspective there is no hope of passing it on to the child. It seems to me that the real core of the issue in teaching science today is that we must ensure that the younger generation, whether they are going to be practising scientists or not, develop a feel for science. They can only develop this attitude if the teacher has it. For the past three or four years the Faculty of Agriculture at the University of Manitoba hosted for a day the science teachers in the Winnipeg High School Collegiate System. These brief visits with short discussion periods brought a new concept to these teachers of the stimulating and challenging opportunities in this important field of applied biological science. At the same time through the joint effort of the Principals of these Collegiates and the University of Manitoba Alumnae Association a number of selected senior collegiate students who expressed an interest in biology and had high academic records were given lectures for four Saturday mornings in the Faculty. As a result of both these efforts a sharp increase in the enrolment, in Agriculture, of good students from the city schools resulted. While it would be difficult to measure quantitatively the effect this had on the students in their high school science courses, I am sure that their interest was considerably motivated by such an experience. This is at least one example of how an apparent barrier to one section of biology was at least partly removed from the minds of science teachers and interested students.

Students should be encouraged, indeed stimulated, to think for themselves. They should initiate their own approaches to an understanding of science. They should read widely and the teaching and selection of examples should not be confined to those provided in the prescribed text.

Some kind of selection or streaming of students is necessary at all ages. We should not be arguing today whether or not brighter students should be accelerated but we should be devising a flexible system to do this while ensuring that there are continual opportunities for the late bloomer to join the accelerated stream. There is usually a fraction of students about whom there is no doubt that acceleration is needed. Why abandon the type of education they need because there is doubt about whether others should or should not join them? Of equal if not greater importance than the acceleration of exceptional students is the enrichment of the curriculum and extracurricular activities.

There should be no difficulty in teaching the techniques of trigonometry or calculus to a twelve year old. The principles requiring the use of these techniques come later. The teacher should concentrate on teaching the essentials of the modern subject. Many examples should be used to bring the student close to real situations in everyday terms. Historical facts and more complex relationships can be introduced later. It is not necessary or desirable to use the mystery of science approach in teaching but rather to rely on the intrinsic interest of the subject itself.

The teaching of science even in the elementary schools is very important and where possible should ideally be taught by a specialist. The science teacher certainly needs a background considerably beyond that level which he is teaching. It is stimulating to potential scientists for the teacher to indicate areas where knowledge in science is now lacking and present these facts to the young students as a challenge in which they themselves might have a significant part in solving. Care should be taken to distinguish between science and technology and the model so created in its relationship to reality should be treated with care. It is not imperative to have more time on the curriculum for the teaching of science but rather that the time already allocated be used more effectively. This does not mean more facts and more technology but a greater emphasis on principles. Interest in science, like that in any other creative human endeavour, can develop early in the child. There is great need for gifted students to have early access to opportunities to develop their interests in science. Science fairs have played a prominent part in this respect in the United States and seem to have promise in Canada. Much interest and ingenuity has been developed in many students because of this program.

It is important to develop in all students the concept that a knowledge of science is necessary for any occupation as well as for a fully developed social life. Certain fundamentals in science must be taught early even for those not intending to enter university but planning a technical or vocational training. However, a great deal more groundwork is needed for those going on to be graduate engineers and scientists. Mathematics, for example, is vital for technical, engineering or scientific training. This course should be taught as separate subjects as early as possible in the child's academic program. There would appear to be a parallelism between the "new sciences" being taught in many secondary schools today and the "new mathematics" which are just being introduced into many of the systems. Both are attempting to introduce the thinking and reasoning processes much earlier than before and make the learning of facts and techniques have more meaning by indicating a real relationship with future use.

Let us turn for a moment, however, to consider the whole problem of education in the elementary and secondary schools. There would appear to be emerging two kinds of policy which should be considered in any study of the national needs, first, a policy for science education in our schools, and second, a policy in education.

The first policy, for science education, would consider broad principles which might be applied on a regional or national basis that would improve the educational standards of the nation. Whose responsibility this should be or who should provide the leadership for such a development is better known to you than to me. One of the major problems which come to mind under this type of policy for education concerns the subject of differences in the quality of education. The Second Report of the Economic Council of Canada states, "Even the most casual survey of educational institutions and facilities, curricula, qualifications of teachers and other aspects of the highly decentralized educational systems in North America readily suggests that there are major differences in the quality of education -- not only over time, but also at any given point of time between different regions and localities within Canada". Not only does this indicate serious deficiencies in the quality of education in some areas of the country but the differences in curriculum structure and course content between various regions, and indeed in many areas within the same region, imposes a real hardship and severe handicap on those students who by force of circumstances outside their control must move from one part of the country to another. In a society whose mobility is rapidly increasing this problem is further compounded.

The formulation of long and medium term objectives for educational growth in the context of overall economic and social development should be one of Canada's major efforts. The projected requirement of the labour force in terms of educational standards is an urgent national issue. We have begun to improve our vocational and technical training, an area in which we have been woefully weak. We must be more positive in our guidance program for students and attempt to persuade those with the aptitudes and capabilities not suited for a university career to attend these technical schools and become first-rate technicians rather than third-rate scientists or engineers.

Another major problem which needs continuing study and some degree of overall policy formulation is the relationship between vocational and technical schools and institutes, secondary schools and the university. If this relationship is not watched closely there is grave danger that one or more of these groups will attempt to assume the responsibility of the other. This will be particularly true if financial assistance is more readily available to any one group or if a demand develops for graduates of any specific group.

In general terms, a policy in education, in my opinion, is the manner or methods in which the policy for education is implemented. This can be much more regional or local in nature and take into consideration those factors which are considered important for the community itself. It would appear to me that in many cases Teachers' Colleges and Faculties and Colleges of Education emphasize those principles having a more direct bearing on a policy in education. There is probably a high degree of agreement among informed people concerning the goals of science education while the practical matter of how to achieve these goals is likely to be the subject of disagreement. This makes me wonder, therefore, whether the teacher or practising educationist is really in the best position to develop and support a policy for education or whether this should not be done by those knowledgeable and with experience in teaching, but in a position where the fears and practical problems of the methods do not place limitations on more broad and comprehensive planning.

In considering the national needs for science education it is extremely difficult to develop a simple, rational solution. The Report on Financing Higher Education in Canada submitted to the Association of Universities and Colleges of Canada made some attempt to comment on this subject. It states in part:

> "The estimates of the number needed for the health services of the country is an example of manpower planning used to determine the need for immediate expansion of schools of medicine, dentistry, and nursing, for example. But even these have a spurious precision for they are based on current medical technology and current salary levels of professional and technical personnel, and on current standards of living of the population generally. When we are dealing with higher education in general, and even with the education in broad disciplines, the value of estimates of manpower needs seems very low."

It further states in support of this conclusion:

> "First, technological change is unpredictable over the long period involved. In the last fifteen years, for instance, developments in electronics have brought about changes in the demand for the skills and the products concerned that it would have been impossible to foresee at the beginning of the period. Secondly these estimates are necessarily confined to the technical uses of the specific skills concerned, but advanced training in one specialty may in fact develop skills applicable to other occupations. Finally predictions of the future demand for doctors, engineers, scientists, teachers or any other group either assume that rates of pay will remain unchanged or make no assumption on this point."

The Report concludes this section by further stating in part:

> "We endorse the view that the need for highly educated personnel will increase, and we would note that the more highly educated (even if educated by training in a narrow specialty) are generally the more adaptable and mobile. We believe that our productivity may be greater if we encourage all our young people to develop along the lines of their particular abilities and interests, and that our economic policy should be directed to the end that the talents so developed be utilized as fully as possible."

There is no philosophy of education, I believe, with a lifetime guarantee. Science education cannot be standarized this year, no matter how hard we try, and left to run itself like an automatic machine. In the course of the next half-century - the lifetime of children now in our schools - there can be little question that the spread of technology and the waves of political change will alter the aspect of the world. There could be nothing more disastrous than that we should educate our children for a way of life that does not exist.

# SCIENCE IN THE ELEMENTARY SCHOOL

by

David C. Edwards
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Today we are aware of the tremendous advances being made by science. We are equally aware of how necessary it is to keep abreast of these advances. This can only be done if science is taught at an early age.

Until very recently it was the contention of a good many university people that something called science was being taught. But it was not science.

To remedy the situation, Dr. Stinson of the University of Western Ontario and several other university teachers and elementary school teachers developed a course which they thought could be taught to children at the grade six level.

The new course is basically a physical science course. It deals with the following topics:

The Study of Matter
Microscopy
Measurement
Work
Energy
Heat
Biology - the comparison of groups of animals.

The course was developed during the summer of 1964. During the following school year the new course was taught by four elementary school teachers. Last summer the revised course was presented to twenty-five teachers. We hope that next year there will be over one hundred teachers teaching the new course.

In teaching the new course we try to lead the children to discover, for themselves, basic concepts in science. In class, any answer is accepted, if it can be backed up by logical reasoning. We do not do experiments to see if the results turn out the way they are supposed to.

Much of the success of the new course is due to the fact that there is sufficient equipment so that the children can work in groups of two.

It is my personal feeling that the new course is highly successful. In the slides which I am about to show you I think you will see that the children exhibit a high degree of interest in the course.

# SCIENCE FOR ALL OR THE PURPOSES OF NEW COURSES

by

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"In a complex industrial society economic strength derives from technology - in particular the application of science to industry. This in turn is based upon the creative capacity of man and upon his education". This quotation from "Teaching Through Television" (6) indicates our concern for suitable science instruction for our young people. It may not be only the economic strength of our nation that causes our concern, it may be concern for the survival of mankind.

We all know that behind the existing forms of democratic control of parts of this world there is a small scientific and technological elite; the mass of mankind is unable to make adequate assessment of our problems. For these reasons all phases of the education of all ordinary children should be changed. Still a technological elite must always be with us and so the members of this group in our society of the future must be located in the schools of today and they must be given stimulating training adequate for their future roles. (4).

Schooling must be realistic and relevant to pupils so that they can see applications to the roles they will be playing in adult life. A Nuffield Science Teaching Project Publication (2) points out that a realistic world to children is that of adults; not a world of school children. Multifarious science courses are being designed and each purports to an attempt to guide the development of thought and memory processes of children so that they will be knowledgeable and able to function in the society of the future. All this is to the good but the sum-total of procedures (grading systems, materials, time and staff allowances, as well as examinations) used to accomplish this must not demoralize youngsters so that they can not function in their childhood world, for then it will be difficult, if not impossible, for them to perform adequately as adults.

So often we hear that the tasks that workers will perform in the future will be so drastically different from those of the present; and that even in the lifetime of an individual the pattern of activities will change several times so that it is not practical to give highly specialized vocational training to the young. Rather, it is said, the young must be trained to understand general principles or fundamentals so that they will have, in a sense, innate ability to adapt to varying circumstances.

The following seven selected excerpts from an address by Thoday (13) tell of the dilemma that is being faced by all biology curriculum designers regarding the value and stress to be placed on modern findings which some people say should be introduced into our courses. It is also a problem to know exactly what traditional bodies of knowledge or laboratory procedures are irrelevant and should be eliminated.

"_____ we will handicap this development if we do not include enough contemporary biology in our curriculum. But we will also handicap the development if we do not include enough morphology and anatomy.

"_____ the main problem before us ____ how to teach enough old biology and enough new biology.

"_____ Our pupils must continue to hear of old knowledge but must hear of it in relation to the new.

"_____ what is modern biology today will not always be modern biology. _____ what is modern biology ten years hence will not only differ from that we call modern today, but may not even be a direct development from today's most exciting discoveries.

"_____ what we need is a new viewpoint on curricula, the viewpoint of integrated biology.

And with regard to our concern to give adequate training to future biologists Thoday goes on to say.........

"_____ It is no use so altering biology training that it produces an excess of molecular biologists in relation to the number of posts there will be for those with such qualifications, and thus lead to an acute shortage of parasitologists and tropical biologists.

"_____ Our biological education systems must produce systematists and anatomists as well as biochemical geneticists."

The above statements with term substitutions could apply equally to the problems of teaching chemistry or physics in a modern way.

Muller (8) has pointed out that not just some but all men must have revealed to them through persuasive or educational methods that failure of mankind to develop will occur if man does not control his population growth. All men must be aware of factors affecting the social and psychological well-being of man; the nature of disease and starvation; the increase of genetically impaired individuals in the human population; the nature of biological warfare; the diminution of useful resources on this planet, etc. There could be catastrophic misuse of science and technology if men do not understand the applications possible. And yet we must not let the humanists say that science studies do not develop the spirit of man; we in our teaching could carefully stress the esthetic and philosophical aspects of science, then appreciation of the creative forces at work in the universe and in man will be developed just as it was by the classical type of education of past ages.

## The Ideal Approach

The "new thinking" about the teaching of the sciences is that pupils should not have their time wasted in the memorization of knowledge irrelevant to them and to the society they will be members of. Rather, the understanding of the basic principles of a subject gained through the development of good habits of observation and thinking should stand one well in making adaptions to an evolving society. Critical questions appear to be how modern relevant material can be introduced into science courses so as to be in line with the pupils' interests, previous knowledge, and intellectual powers. If pupils are to take an interest in their studies they must become more involved......"active interest" is an expression familiar to all today.

## Seven Educational Factors

### Teachers

In any teaching programme the teacher is directly concerned with many factors other than the knowledge that must be transmitted. But, the teachers' grounding in the knowledge to be imparted, the teachers' inspiration and their understanding of nature are items they themselves must be very honest about: their superiors must be careful to nurture and use these attributes properly. Pode (10) has pointed out how "exceptional" teachers are required for the C. S. A. course. The P. S. S. C. also depends upon the teacher according to Poorman. (11) Let it be said again....that administrators must select and train the secondary school science teachers carefully, and so that teacher morale is not "dreary in the extreme" (Bishen) teachers must be provided with all necessary assistance and physical amenities.

Teacher training colleges must provide academic courses in all sciences for all future elementary school teachers, and the colleges in co-operation with school boards must make available renewed training services for all teachers. It might be that science specialists in the elementary schools should become the rule.

### Students

As Thoday (12) has pointed out students have certain abilities and motivations which will help or hinder them in their learning. However, the destiny of the student, be it general employment or university studies must not disturb the teaching-learning process.

I am in a predicament when asked to make decisions about streaming or selection of students for different types of education. I do tend to favour giving more sophisticated work to students having the attributes which could result in their proceeding to university studies and possibly careers as research workers, but I have to admit that perhaps I am not being fair either to the more mature and intellectually superior student or to the less mature and possibly intellectually restricted youngster if I segregate them. The fast learners often develop unhealthy attitudes that might be just as difficult for teachers to conquer as the feelings of inferiority developed in students relegated to the classes labelled "general", "practical", "opportunity", etc. In fact the "educational slums" (term applied by Edward Blishen) described by Partridge (9) as occuring in the secondary modern schools England makes one realize that streaming can be dangerous. Blishen used very strong language saying that masses of children were conforming to the opinion that education is not for them; large numbers of delinquents, permanently soured, and uncooperative members of society are being produced in England. "Those," to quote again from Blishen's review, "in need of the best schooling have the least skilled teachers, the most discontinuous timetables, the fewest books."

Could not one solution be to segregate only the exceedingly bright and interested from the most vigorous courses we can devise; and to keep the average and below average together in small classes that the teachers could handle even to the extent of doing some streamed work with groups within the class?

Courses

The Nuffield Science Teaching Project (2) recommends a general science programme which should be spread over a three year period for children of 13 to 16 years of age. One suggested course which has as its unified theme or philosophy human biology and physics (energy..manifestations of, study of, and uses of) will permit average and below average children to get an overall picture of the personal, social, and moral implications of scientific knowledge. Children slow at being able to grasp generalizations must be led carefully through such a course so that they eventually do see connections or interrelations between subjects other than science in the curriculum and all the divisions of science.

Other Nuffield programmes indicate that exceptionally bright children could get training for some three or four years in chemistry and physics, and possibly five years in biology, each course running concurrently. Selection of students for such courses would have to be made when the children are about 11 years of age.

Examinations

Examinations must not impair the success of teaching (12) This surely does not only mean that we improve the nature, design, and philosophy of examinations that accompany any particular syllabus, it must also mean that the examinations designed for the "average" student taking an "average" course should be considered suitable to use as university entrance examinations.

The average person usually makes as good, or even a more valuable contribution to society as a person judged to have a superior intelligence. Hence the average person must not be discriminated against with regard to eligibility for university training.

Time Allowances and Maturity

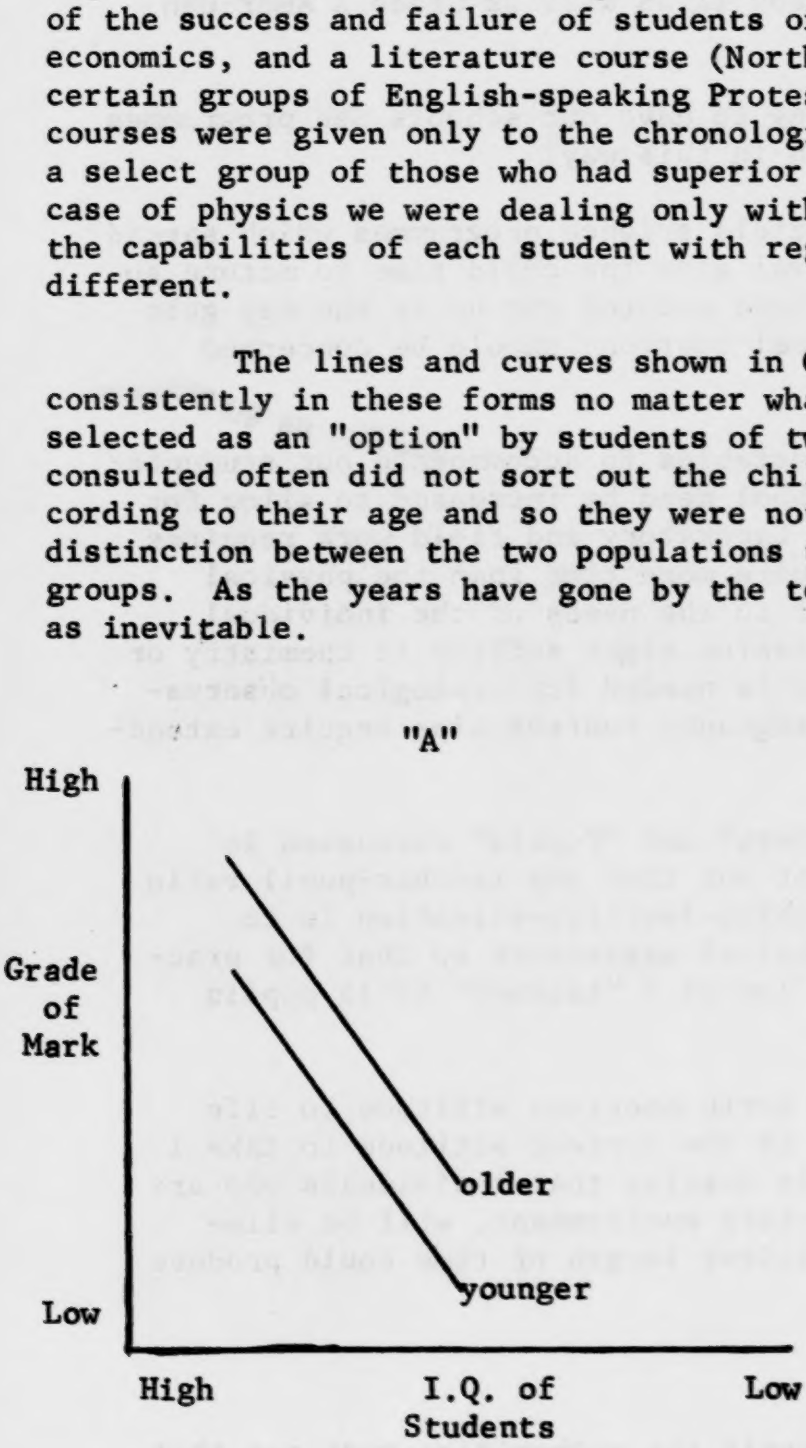
Naturally it follows from the preceding discussion that the length of time devoted to any syllabus is very important. In teaching many of us who wish to use devices such as teaching machines only for remedial work, believe that the most important factor in education is the interaction of the minds of the pupils and the teacher. Therefore, time must be allotted this. Practical work in the sciences also demands much time. The North American habit of rushing through one or two science courses in an academic year is not producing scientifically knowledgeable young people.

By distributing the subject matter of all science syllabuses over several academic years, as is done in Europe, results in the European students receiving a significantly greater number of hours of instruction than it is possible to give to most North American students (approximately 250 versus 170 hours). Scientific concepts are only fully grasped by mature minds. Maturity comes slowly to some "normal" children. Are North American students to be penalized by having been shunted off into low streamed groups which will never be presented with problems of any depth or by possibly being rushed through work in such a way that the pressure causes demoralization?

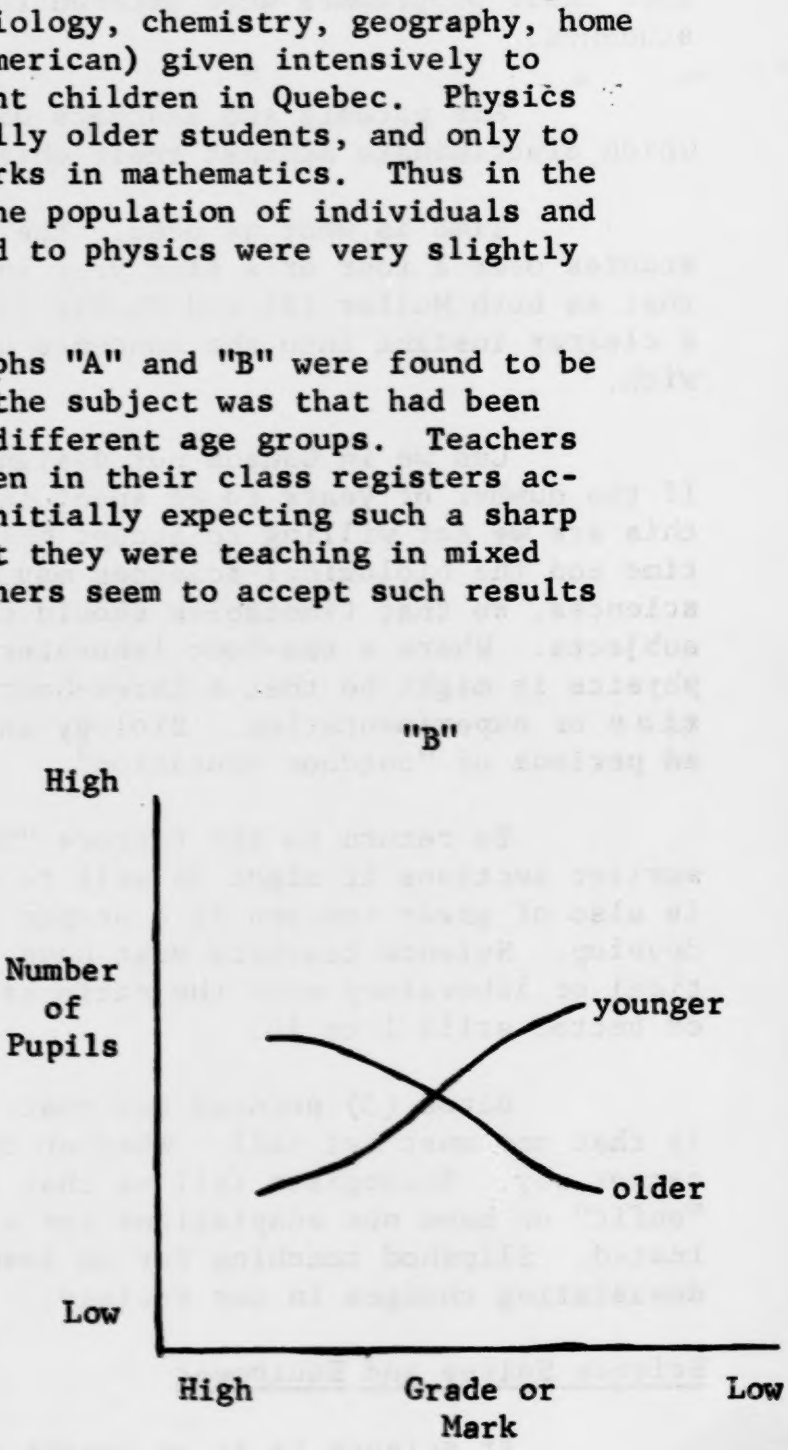
By allowing students to choose their single-year option courses any time between their 14th and 17th year much harm has been done and is continuing to be done. Between the years 1958 and 1962 I collected data telling of the success and failure of students of biology, chemistry, geography, home economics, and a literature course (North American) given intensively to certain groups of English-speaking Protestant children in Quebec. Physics courses were given only to the chronologically older students, and only to a select group of those who had superior marks in mathematics. Thus in the case of physics we were dealing only with one population of individuals and the capabilities of each student with regard to physics were very slightly different.

The lines and curves shown in Graphs "A" and "B" were found to be consistently in these forms no matter what the subject was that had been selected as an "option" by students of two different age groups. Teachers consulted often did not sort out the children in their class registers according to their age and so they were not initially expecting such a sharp distinction between the two populations that they were teaching in mixed groups. As the years have gone by the teachers seem to accept such results as inevitable.

"A"



"B"



Graph "A" shows what one might expect when one considers the intelligence of the individual student and his or her degree of success. Generally speaking the brighter the child the better his or her achievement. It can be seen that the younger pupil having an intelligence equal to that of an older pupil can not, in general, achieve what the older child can.

Graph "B" seems to indicate that the younger pupils will produce a higher number of failing students and a lower number of students with first class marks. Apparently similar observations were made by B.S.C.S. officials when their programmes were offered to grade IX as well as Grade X American students.

Are parents and teachers willing to have our schools use programmes which discriminate against their children in this way?

Time is what we need. The Nuffield science programmes which spread studies over a four or a five year interval give the child time to mature so that as both Muller (8) and Thoday (13) have pointed out he or she may gain a clearer insight into the concepts we feel everyone should be concerned with.

Can we in Canada not design timetables to accommodate our students? If the number of years to be spent in school need be increased to allow for this are we not willing to accept this? Laboratory and field work requires time and the biological sciences may require more time than the physical sciences, so that timetables should cater to the needs of the individual subjects. Where a two-hour laboratory session might suffice in chemistry or physics it might be that a three-hour one is needed for biological observation or experimentation. Biology and geography courses also require extended periods of "outdoor education".

To return to the factors "Teachers" and "Pupils" discussed in earlier sections it might be well to point out that the teacher-pupil ratio is also of great concern if a proper teaching-learning-situation is to develop. Science teachers must have technical assistance so that for practical or laboratory work the ratio is as low as 1 "teacher" to 15 pupils or better still 1 to 10.

Bates (3) pointed out that the North American attitude to life is that one must not fail. Whether this is the correct attitude to take I cannot say. Biologists tell us that it is destiny that individuals who are "unfit" or have not adaptations for a certain environment, will be eliminated. Slipshod teaching for an insufficient length of time could produce devastating changes in our society.

## Science Suites and Equipment

If science is to be taught properly the authorities must see that adequate physical facilities are available. For the modern science programmes laboratories must be provided in sufficient number so that groups of children can leave equipment set up for long periods of time in order that an experiment can run its course (this is possibly of concern only to those involved in biological studies). The scheduling of laboratory classes and use of the laboratories must also take into consideration that such rooms must be available to the teacher and/or his assistant during times when they wish to prepare for the classes they will be conducting.

Grobman (7) has pointed out how overwhelming the workload of a science teacher is. Therefore, this must be reduced to allow the teacher more time to prepare for classes and to do the checking or correcting of pupils' work. People advocate that students have their homework loads reduced...well then why should teachers be the only members of society who expend enormous quantities of energy all day and then have to spend four or five hours in the evening on more preparation and correction?

Offices, preparation and storage rooms are other physical amenities that can make a science teacher's life less harassed if they are well designed and correctly located in the school building in relation to the lecture rooms, laboratories, and library or reading room.

## Curriculum and Syllabus Development

Thoday (12) has pointed out that there can be no finality in any particular curriculum. That we are willing to recognize this is seen in the number of times some of the American and British courses in chemistry, biology, and physics have been revised following evaluation by teachers.

Chairmen of B.S.C.S., C.B.A., CHEM Study have emphasized that it would not be wise for anyone to select bits from the three different biology programmes, or from the two different chemistry programmes in order to create another biology or chemistry programme. It is a known fact that the philosophy which led to the development of each course is different, yet I am not convinced that the individual teacher could not remould the best parts of various texts or courses to produce a thoroughly adequate course. O'Callaghan points out in the summary of the O.E.C.D. Greystones convention on "New Thinking in Chemistry" (1) that the three outlines for chemistry courses produced at that convention could readily be developed by well qualified teachers to provide a syllabus suitable to the needs of their own students.

We must beware of being trapped into accepting courses simply because the proponents of those courses have a vast and powerful promotional or advertising body behind them. In the case of one such course Pode (10) says only the most exceptional teachers could handle it. Have we many such people? In the case of another course Poorman (11) says too that teachers will pose a problem; while of the same course Brauer (5) says that for certain sections of the course the material is not relevant to the students since it is too highly theoretical and can not explain common everyday occurances or the working of common household gadgets.

Can not Canadian design science courses using the best of the laboratory or data survey approaches of American and British programmes, and of course any devices that our own Canadian teachers may have found effective? The cost of developing Canadian courses that can allow for regional and even individual teacher and pupil needs, need not be overwhelming. The Nuffield chemistry programme makes use of printed sheets suitable for the students loose-leaf note-book. Revision of such teaching aids is both time saving and inexpensive. Grobman (7) has pointed out that in the U.S.A. the N.S.F. had not (in July 1965) given its approval for revision of the B.S.C.S. materials that have now been published in hard cover books. Such a situation can stultify curriculum development. An interesting Grobman phrase is "content determination by non-academic market place". This can mean not only that publishers, rather than authors, might select what is in books, but what was mentioned above, that curriculum development is impossible if texts and manuals are not continually rewritten and modified.

Summary of Problems -- Finance and Advancement

The key to the updating of science education in Canada is as it is in all countries the provision of funds so that ________.

1. Committees can design new courses for elementary school children as well as secondary school students.

2. Updated printed material for the new science courses can be made available to all concerned.

3. Adequate teaching personnel can be recruited and trained. Such personnel will include not only teachers but also laboratory and clerical assistance. The teachers workload must be reduced as must the teacher-pupil ratio.

4. Elementary teacher training colleges must accept as students only those with adequate science background. If the trainee is accepted without such a background the teacher training college must provide it. Otherwise science specialists must become the rule in elementary schools.

5. High school teacher training institutes must give a thorough review of the principles and history of science to the future teachers of secondary school science. Secondly, these institutes must demonstrate thoroughly how to develop, administer, and teach the programmes we call "modern science".

These actions are possibly the direct concern of a Department of Education, while the next three problems will have to be solved by local or regional school boards:

6. Reference books of suitable quality and number must be provided for all classes.

7. Laboratories, lecture rooms, preparation rooms and study rooms must be increased in number in every school. Suites in what have been considered the best schools of the 1950's and early 1960's are totally inadequate for programmes that began to take shape in the 1950's.

8. Adequate laboratory equipment and audio-visual aids must be provided for the science suites.

A "Canadian Association of Science Specialists and Educators"

A strong association of ly the best qualified science teachers, scientists, and industrialists could co-operate with departments of education and school boards regarding the constant updating of curricula, teacher training, and school procedures.

As concerned Canadians we must all unite and work to the limit of our strength to establish the highest possible standards in our schools, for as Bentley Glass said in his final note to the B.S.C.S. as its chairman .... "freedom is fragile if citizens are ignorant".

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## THE NEW SECONDARY SCHOOL COURSES

by

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It was with a great deal of pleasure that I accepted the invitation of the committee in charge of this programme to attend and speak at this C.T.F. Science Teaching Conference. For many years I have had a great interest in the possibilities of co-ordinated effort between the Provinces of Canada, and even on an international scale, to produce courses which would be taught throughout the continent and would allow transfer readily from one place to another.

My first interest in this work began in about 1952 on a visit to the National Science Teachers' Convention in the city of Chicago. At that time I listened to many reports given by our American colleagues, telling of the things that they were doing in curriculum, the advances that they were making, the changes that were occurring in their methods, and so on. I became convinced that here was a massive effort being devoted to repetitious work in fields that required a co-ordinated approach. My interest was rekindled in 1961 at a similar conference, again held in Chicago, at which a number of representatives of the various provinces of Canada got together in an evening, and in their discussions expressed their conviction that a co-ordinated effort was possible in Canada if the necessary changes could be initiated through the teachers themselves. During the years from 1958 to 1962, I had the privilege, as an Inspector of the Ontario Department of Education, of visiting most schools in the Province of Ontario and seeing, among other things, science classes in those schools. There are almost as many opinions among science teachers as to the requirements of our science courses as there are science teachers themselves.

I have been asked to discuss the new secondary courses under the topics of principles, purposes and problems. Let's look first at the principles behind the courses. Shortly after my arrival in the Department in 1958, the need was apparent that there should be changes in the courses of study set up in science classes from their beginnings in the elementary schools through to the end of grade 13. A start was made with the first changes introduced in the courses of 7, 8, 9 and 10. These levels were chosen because there was need, it was felt, for fairly rapid changes at the senior levels, and it was not practical to begin the changes at the very early grades and introduce them, as some might think best, in the lowest grades and progress one year at a time through to 13. There was considerable criticism of the courses that were introduced in 1961 in Curriculum I: 1 (e) because they did not introduce enough of the new topics to suit some members of the profession. However, it was felt by the committee at the time that one thing in particular was necessary, and that was to restore some order out of the chaos that had resulted from the turning over of local courses of study to local committees on curriculum which, by the way, are still in existence in some places. These local committees, exercising the prerogative given to them in the departmental memorandum of 1950 which provided for the revision of courses within a local school system by a co-ordinating committee and teachers' committees, devised their own courses of study to meet their own ideas of progress. As a result of many committees working in various parts of the Province, science teachers in particular were galloping off in all directions and the result, of course, was apparent. Youngsters who moved from one system to another were completely lost. They missed that essential of science that we are trying to teach - the orderliness of everything within the universe.

It was the thinking of the curriculum committee members that worked on the intermediate division science courses of 1961, that these would lead with some continuity into the courses that were to follow. As it happened, many members of the 1961 committee were appointed to the committee which was soon to study and revise the grade 11 physics course. The new course in many ways resembled the course that it replaced. It did bring down a number of concepts from the grade 13 level which were thought suitable and valuable for the grade 11 group of youngsters. The course of study itself did not lay out the method by which the information was to be taught. This brought criticism in that some teachers have felt that unless a physics course is taught in the manner suggested by the P.S.S.C. group in the United States, it is no longer good physics. This concept has been strengthened by some of our university professors who have felt that anything that was not P.S.S.C. was old-fashioned and therefore useless. It has been the contention of many over the years, however, that a course should be laid down as to content, but that the method of teaching should be left to the teacher. There is certainly no thought in my mind that there is only one way to teach any subject. We are not trying to teach a particular set of facts but we are trying to teach the youngsters to think, and in this case, to think scientifically. I would maintain that there are many ways of doing this and that the good teacher will use those parts of the P.S.S.C. methodology that he thinks best, or will use those parts of traditional method which have proven to be effective over the years.

The last section of the grade 11 course of studies was chosen as nuclear or atomic physics in order to lead directly into the concept of chemistry that many on the committee thought was logical in an approach to the subject. It was very unfortunate at that time that no member from the grade 11 curriculum committee was chosen to serve on the grade 12 and 13 chemistry committee, and there is no doubt that this caused a breakdown in the continuity of thinking which had begun with the early intermediate division courses.

The committee working on the grade 13 course of study in physics decided that a logical approach was that of the P.S.S.C. course developed in the United States because at the grade 13 level most of the youngsters were studying this particular university level. It was felt that the course could be handled at the grade 13 level because the students who would be studying this particular course would have had a background of traditional physics at the grade 11 level. Similarly, the grade 13 biology course was built on the background of the grade 9 and 10 courses in general science. In grade 9 the student had been introduced to zoology at a level which followed up his elementary training, and in grade 10 almost half of the year had been spent on botany. The new course in grade 13 biology was a combination of the old botany and zoology, brought up to date and intended to lead on to university courses and save considerable time at that level as well as giving a good general background in biology to students who were taking it for general purposes. I have not yet had an opportunity to study the new course to be introduced in grade 13 chemistry.

There is no doubt in my mind that in developing these new courses, and I have not dealt with the new 4-year options at all, the principle of continuity has been kept always in mind. There has been an updating of material, and there has been a constant effort to introduce concepts of interest and value to the student, whether he is to specialize or generalize in the subject in later years. There has been an effort to provide material that is of current interest and also to provide the background for the student who wishes to go on.

Changes such as these do not occur easily. For many years teachers and students were accustomed to the idea that one text in a subject provided all the answers. Today, we know that a good text raises only a number of questions, and that it takes several texts to provide even the basic background for a good course. Let's talk a little about the textbook problem. In many cases, a new course has been introduced for which there has been only one textbook available at the time that the course came into effect. Other good texts followed close behind, but too late for introduction to the schools for that school year. With the concept that we should provide textbooks from grade 9 to 12, it has meant that when a text was introduced in a particular grade at the start of a new course, that text very often has gone on and on, although a better text in the opinion of the teacher might be available. Many of our textbooks have been written by teams of teachers, or more recently, by teams of teachers plus university professors. In the first case, with teams of teachers doing the writing, there has been frequent criticism from the university levels that the material was not of sufficient depth or accuracy to provide what was needed to teach the course. In the case of those written by both teachers and professors, there has always been danger of overbalance by the senior author and the introduction of material that was actually beyond the needs or understanding of high school students. The multiplicity of topics covered in the various science cources in the provinces of Canada has limited the use of any particular textbook usually to the province in which it was written. This, of course has meant that it is more expensive to produce the textbook because of its relatively limited distribution, and also that the authors for any particular text are usually limited to the teachers of that province itself. There is no doubt that, because of these problems, we miss out on a great deal of talent and also that we lose in the quality of production of the textbooks that we are using. A student moving from province to province during the school years is faced with an almost impossible predicament. He is confronted with different texts, different concepts in the course of study, and vastly different timing of the various topics.

The teachers, too, have had their problems. I do not feel that the changes that have occurred in grade 7, 8, 9, and 10 or even 11, have caused particular difficulties, but the introduction of so many changes in the senior levels, particularly in grade 13, certainly has given rise to many worries. The category system, introduced for payment of salaries in Ontario and widely supported by the O.S.S.T.F. and even the Department of

Education, which stays away from salary matters, has caused problems, too, for the teachers. There has been an almost constant pressure on the young teacher to upgrade himself, to take course after course at the university level, to raise his category from I to II to III to IV, and so increase his salary status. This has meant that the young teacher who has entered the profession by the summer course route and has taken one course after another to upgrade his university qualifications for endorsement, and finally, after more courses has reached the specialist status, has been forced to attempt two important jobs at the same time - to teach and to study. In the meantime, two things have happened. One, he has had little time left to prepare his day-to-day lessons, and two, he has had little time to update himself in the information that was of particular value in the subject that he was teaching. Far too often the courses assigned for his improvement in category have been remote from the subjects that he was teaching in his school.

For the teacher in the large system updating has not been an impossible task. The chances are that the teacher has been specializing in one major field in particular. However, in the smaller district schools, a teacher of science who has been a specialist over the years is likely to teach more than one of the senior subjects. When this is the case, if we should introduce new courses in physics and chemistry and biology within a short period, that teacher is faced with a very heavy assignment. It is unlikely that he will be able to do justice to all three of these subjects during that period and, of course, it is the student who sufferes in every case.

The problems of equipping schools for these new courses is one of relatively major proportions as well. It is all very well to say that we are spending only a small percentage of the nation's capital on education, but at the same time we must realize that current budgets cannot send the tax rate soaring in any individual year. That is not a practical approach to the problem. It has been the custom over the years, and I think it must remain the custom, that we keep our budgets within reasonable limits. Increases in taxation, if they must occur, must be gradual, so that no-one is hurt too severely at any one time. The increases required in science budgets over these past two or three years have been very significant.

In spite of all our difficulties we have not had the problems with the new courses in science that have been prevalent in the introduction of the so-called "New Mathematics" in the secondary schools. We have not had to introduce such radical new concepts in the middle of an educational programme. We have been fortunate in that changes in topics from one grade level to another can be done with a minimum of disruption to either staff or students. It is only, it would seem, at the grade 13 level that we have had a real difficulty, and this difficulty I maintain, is one that is capable of solution within a relatively short time. Many administrators have joined with teachers in bewailing the fact that these changes are coming too fast and without enough study. I maintain that if a change is worth making for educational purposes, it is worth making at the time that the decision can be implemented. If we wait until all of the problems are solved, until new textbooks have been written, until our staffs have been retrained, until our schools have been re-equipped, it will be time for new changes.

We must learn to live with constant change of courses of study. Our teachers must be prepared to keep themselves up-to-date. As professional people, they are being paid as experts in their own fields, and, of course, must use their own time and their own effort to maintain themselves as experts. As administrators, we must provide not only money but encouragement and the maximum opportunity for the updating of our teachers.

In conclusion, may I say how noteworthy it is that I was asked to discuss the principles, purposes and problems of the new courses, and I was not asked to offer my solutions. I would hope to have an opportunity in the discussion period to add some of my own ideas on this particular portion of the topic.

# PRINCIPLES, PURPOSES AND PROBLEMS OF THE NEW SECONDARY SCHOOL SCIENCE COURSES

by

Mr. L. W. Steele
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## A. Introduction

Mr. Chairman, fellow panelists, ladies and gentlemen.

It is indeed a pleasure to be able to participate in this worthy conference. It has long been a personal desire of mine to see the formation of an active, national association of Canadian science teachers. I commend the officers of the Canadian Teachers' Federation for the leadership which they have demonstrated in organizing this conference of science educators. In so doing they have made it possible for that intimate interplay of personalities and intellects to occur which must precede the formation of any official organization.

It is a privilege to meet so many of the leading figures in science education from across our nation. I look forward with high hopes to the continuation of the professional associations which we are making today. I extend a warm invitation to all delegates to contact the officials of the Ontario Department of Education in order to discuss our problems of mutual concern. It is hoped that we may in turn have the privilege of visiting you in your various Provinces.

From coast to coast we find educators at all levels working with great vigour to meet the challenge of educating children for the rapidly changing world in which we live. Qualifications demanded of teachers are moving upwards as are the salaries to attract personnel of the high calibre required. Teacher training institutions are increasing in numbers as is the scope and intensity of the courses which they offer. Teacher organizations are assuming greater responsibilities in the area of professional development. Departments of Education are ever increasing the number and scope of the services which they offer to assist the teacher in his demanding role. Different aspects of this stimulating endeavour are being discussed at the various sessions of this conference. This afternoon we are directing our attention to the new secondary school science courses.

## B. Principles and Purposes

Science curricula in the past have attempted to present a carefully constructed, sequential development of topics from year to year throughout the secondary schools. It was hoped that secondary school graduates would thereby acquire a reasonable compendium of scientific facts for their future life and also gain a sufficient understanding of scientific principles to form an adequate preparation for university work in science if desired. The phenomenal rate of increase in scientific knowledge in recent years, and the impact which that knowledge is having on our society, has made it apparent to all concerned that educational practices of the past are not necessarily sufficient for demands of the future. Science courses in the past have tended to be neat packages with no loose ends where the emphasis was on the facts rather than the processes.

As a result of considerations such as these, much emphasis has been placed in recent curriculum research in presenting science as what has been called a narrative of inquiry rather than a rhetoric of conclusions. Student-performed laboratory experiments in which both successes and failures are expected and contribute to the student's appreciation and understanding of science play a major role in the course development. The predominance of open-ended experiments, the increased emphasis on individual study by students followed by group discussions and, the accompanying decreased emphasis on formal lesson presentations by the teacher, are all designed to assist the pupil in developing his facility of self-instruction.

## C. Problems and Their Solutions

Coincident with the changed emphasis in approach has come an up-dating and re-evaluation of content. For those of us who graduated from university some years ago, some of the topics which are at least introduced in the new secondary school science courses were not included in our undergraduate courses. The wave mechanic theory of atomic structure, certain aspects of modern molecular biology, and modern theories of chemical bonding are topics which require additional study by many of us in order to have a sufficiently firm grasp of the subject in order to feel at ease in discussions.

It is evident that I have been referring to such courses as the B.S.C.S. biology, the CHEM Study and C.B.A. chemistry, the P.S.S.C. Physics and the Introductory Physical Science courses. These courses, developed by large numbers of educators working for several years, and underwritten by generous grants from various organizations, were developed for schools in the United States. Due to the different backgrounds in science education, the difference in the academic requirements which influences the nature of the science student population, the time allowed for science instruction, and the additional academic load which students carry, it is impossible to make direct comparisons of the suitability of these American-designed courses to the Canadian educational system. Obviously each Province must develop its own adaptation of the original course, if indeed they wish to use this material at all, in order to arrive at a curriculum suitable for their particular educational system.

What can the Department of Education do in order to assist teachers in making the necessary adjustments and to work with teachers in the development of the most suitable courses of study for their Provinces? Examination of the national educational scene reveals that procedures such as the following are being practised in one Province or the other:

### 1. Summer Institutes or Saturday Institutes

Departments of Education, universities, local Boards of Education and teachers are cooperating in various ways to organize Institutes.

Two aspects of the problem are being dealt with here:

(a) Up-dating of the teacher's background

(b) Introduction to the philosophy and techniques of presentation of the new courses.

Probably different regions are having more success in the handling of one aspect than the other. Undoubtedly our ability to deal with both aspects effectively will improve as we become more experienced in this endeavour.

Here in Ottawa, the physics teachers have received very valuable assistance from an association of professional physicists. The Ottawa Branch of the Canadian Association of Physicists has formed a Science Education Study Committee to study the problems of science education and to give assistance in overcoming these difficulties. Hence a series of Saturday sessions was presented last year for the benefit of teachers of the new Grade 13 physics course in Ontario, which is based on the P.S.S.C. Physics course. This series was organized through cooperation of the physicists and the Ottawa Collegiate Institute Board. The physicists have also made arrangements to assist the teachers in the problems associated with equipment evaluation and maintenance.

## 2. In-Service Workshops

Workshops are being held in all areas of the Province to continue the program of assistance to teachers which began in the Institutes. In some cases the workshop may consist of a getting together of the teachers in a local area to discuss their mutual problems with each other and perhaps a Department official. In other cases, teachers from another area may participate as resource teachers in these discussions.

Science teacher organizations are taking an active role in assisting in both the financing and organization of workshops.

## 3. Curriculum Study Guides

In order to assist the teacher in both the interpretation and presentation of the course, Departments of Education have either included explanatory material with the curriculum publication itself, or have issued separate Guides.

It is probable that a more extensive use will be made of this avenue of assistance than has heretofore been the case.

### 4. Educational Television

Departments of Education are experimenting with the particular abilities of television to assist in course presentation.

This aspect of pedagogy is still in its infancy and educators anticipate great developments as this infant grows and matures.

### 5. Close Liaison with the Classroom

Close liaison with the classroom is required if curriculum personnel are to develop courses which are suitable for the students concerned.

If I may be excused for giving a specific example from the local scene once more, I would like to mention that in this regard the Ontario Department of Education now has a number of subject specialists working full time on curriculum development and implementation. It is expected that this organization will make it possible to improve both the integration within a given subject field from Kindergarten to Grade 13 and the coordination of the subjects one with the other, at all grade levels.

As part of their work in this area, the subject specialists concerned are attempting to spend a significant portion of their time visiting classrooms in order to assess the suitability and effectiveness of the various curricula from personal observation. The comments of the teacher are also carefully considered and reported to curriculum committees for their guidance.

## D. Conclusion

Many practical problems of curriculum development and implementation could be reviewed, however, these are concerns which might better be considered in the discussion if desired.

As I am associated with the Ontario Department of Education, I would be remiss indeed if I did not at least mention the studies which are currently in progress in this Province to determine both the advisability and feasibility of introducing General and Advanced Level courses at the Grade 13 level of instruction.

Curriculum committees were formed this Fall to prepare broad, suggested outlines of proposed courses at both the General and Advanced Level for consideration by educators. I have here a few copies of the proposed course outlines in Biology, Chemistry, Physics and General Science. Current deliberations and the comments which the Department receives from university and secondary school personnel will assist the Minister in deciding if it is advisable to experiment with these courses or not. You are welcome to take a copy of these reports if you wish.

I have attempted in the last few minutes to outline some of the Principles, Purposes and Problems of the New Secondary School Science Courses as seen from the viewpoint of a curriculum official. I hope that in the discussion period following we will have the opportunity to examine this topic in more detail.

# INTERESTING THE GENERAL STUDENT IN SCIENCE

by

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From birth humans are interested in investigating the environment around them. Most of us upon investigation of that pink thing that waved to and fro blurrily in front of our eyes found it to be our own toe and thus achieved our first investigative success. Curiosity about the world around us follows intelligent humans all through life from this time through dabbling in mud puddles on the way to kindergarten, to the discovery that animals and plants are of different kinds in grade school and to the first elementary lessons in formal science in high school. The interest in investigation of the environment seems to be fundamental.

As for the title "Interesting the General Student in Science" it has always been a matter of importance to me that there is no fundamental difference between interesting the general student in science and interesting the general student in anything else because it always seems to come down to the same fundamental factors. We could, perhaps, list them under three headings: subject matter, its presentation, and the social background.

## Subject Matter

The subject matter in science ranges from the most abstract mathematics to pure description to cause and effect observation. Men are curious and the world is an interesting place. Science is fundamentally interesting.

## Presentation

The presentation of any subject is a vital part in stimulating interest in any student on any subject. I suppose the first part of presentation which is important is to have qualified teachers with some knowledge to impart. The second general requirement is to have some knowledge of techniques, not only of pure communication from one human to another but, in science probably more than any other activity, an ability to impart a sense of participation in discovery is a vital ingredient.

Yet there is one aspect of interesting the general or any other student which is even more important than qualifications, knowledge, or technique. That is enthusiasm. In my own experience with teachers, both as a student for many years and as a professional teacher on a variety of university staffs I have found again and again that the successful teachers are those with enthusiasm - enthusiasm for their own fields of interest, and enthusiasm for sharing it with others.

One of the prime duties of the science teacher, I have always thought, is to remove the mystery from science to make it into something natural which is what it fundamentally is. Nowadays we hear a great deal about the conflict between the two cultures, the arts and creative endeavours on theone hand and science and technology on the other. Scientists are often painted as the orges who invented the bomb and got the whole of civilization into terrible trouble. Science itself is surrounded with an aura of mystery and placed upon a pedestal it does not rightly deserve. If science can be generally described as a systematic investigation of our environment then it can be a thoroughly natural and logical part of our activities. The child in grade four, the high school student in the first lab. he has seen, the university student in more advanced work and finally the research director in a major institute may all be doing exactly the same thing - observing, experimenting, testing, and concluding about things he has seen and done.

An important part of attracting the general student in science in my teaching experience has always been the necessity to make an effort to make science and the investigative procedures compatible with a love of beauty. It is important to communicate to students, I think, that the patterns of trees, the green grass, the curving river and the colours are very beautiful. For the man who understands the infinite variety of natural processes spread out before him, how the river is evolving slowly over the thousands of years, how the chlorophyll in the trees and plants utilizes the sun's energy, and how the glacier on the distant hill operates can feel not only the original sense of beauty but have other channels of appreciation just as profound and moving as well.

Perhaps in no other field of human activity can a student be made to realize as clearly as he can in science that the knowledge of today is but the point of a tall pyramid. It is interesting to think that the most elementary course in chemistry or geology or biology or physics in universities now imparts knowledge far more broad and profound then the leading minds of a half century ago were able to penetrate. Seventeen year old kids know far more about the physical world than Newton or Galileo or Darwin or Kelvin did at the heights of their powers. It is, I think stimulating and necessary for students to realize that we climb the heights only on the shoulders of others who have gone before us.

## The Social Background

It may seem a little odd in a general talk on interesting the general student in science to mention the social background and yet this is a vital part of the education process. In the first place learning must be made a respectable activity generally through the community. Very few of us are too young to remember the "egg-head" attitudes and talks in the United States of a decade ago. In some societies learning is much respected, in others it is laughed at. A fundamental part of stimulating interest I think is making sure that it is realized that in particular and knowledge in general are respectable things.

In connection with this, it would be very valuable for us in Canada to have some sort of national identity in science. At the present time in this country science is very much on a hit or miss, helter-skelter sort of arrangement. There seems to be no national purpose and no national direction. Canadians are not world renowned for their efforts in particular branches of science which might be said to be related to their particular resources, or needs. I am sure that it would be much easier to interest the general student in science if everybody knew that Canadians were outstanding in agriculture or oceanography or -- you name it.

For such a national identity in science to be achieved it is probably necessary to have some sort of national directive body in science which would be able to advise or even decide to encourage activities in certain lines. With such an enormous expanse of the earth's surface within the boundaries of this country it would seem logical that the Earth Sciences would be one place where Canada should place a great deal of emphasis. With enormously long shorelines, tremendous areas of the continental shelf under our control it would seem again logical that Canada should pour a great effort into learning something about the Continental Shelf and the near shore parts of oceanography. With this country being one of the main bread baskets of the world it would seem logical too that a great deal of our scientific effort should be directed to a better understanding of those processes which bear upon agriculture and its biology. It would seem that somebody or some body of men, distinguished in several fields, could advise governments and universities whether it is in our public interest to spend great sums on atomic sciences at Chalk River, to send the Alouette into space on the top of an American rocket, to do particular kinds of chemistry or physics or biology. This does not in any way imply that we should discourage initiative and enthusiasm in odd branches of sciences or for odd people with talent. Creative things have almost always come about through the efforts of intellectual non-conformist. Yet we lack a national identity in the sciences.

What to do

Now, aside from these generalities what specifically can we do to interest the general students in Science. Nowadays there is an enormous number of aids to teaching - superlative movies are available in an enormous variety of subjects; television programs of great variety, great beauty of production and depth of information. Magazine articles, illustrated often with beautifully conceived and executed diagrams, are abundantly available. Prepared experimental apparatus, often of an astonishingly simple and economical type, makes science come alive. World-wide coverage of natural phenomena, great volcanic eruptions, the migration of fish, the occurrence of cyclones or the phenomena of the upper atmosphere are all day to day events. Thus in addition to enthusiasm, proper techniques and presentation, qualified teachers with knowledge have at their disposal a tremendous variety of tools for interesting the general student in science. The respectability of learning in general and science in particular, the encouragement of a national identity in science and the feeling of going in some particular direction are things which may well depend on interesting the general student in science and in their turn it will make it easier to do so.

# SCIENCE OUTSIDE THE CURRICULUM - FOSTERING EXCELLENCE

by

John M. Anderson
Director (1964-65)
Royal Canadian Institute Summer Science Program

"I have learned that there is a great excitement in learning; that to stretch one's mind is a profoundly moving experience; that there are teachers who do not command learning but invite it; that science is a vibrant flood of discoveries, a synthesis rather than a collection of facts". This was written by a grade 12 Ontario student last August. He had just completed a six-week summer science program sponsored by the Royal Canadian Institute. He was no ordinary student, however, and the program was equally unique.

This morning I want to tell you something about this program. I think you will find it interesting for this program takes some of the best students from your schools and puts them into an academic setting which could only exist under the very special circumstances which the opportunity of the program provides. The general student is excluded. We are concerned only with the exceptional one. I make, however, no apologies for our exclusiveness. While I readily agree that more should be done for the general student, I submit that there is, in relative terms, a much greater need in Canada for directing special attention at the small number of exceptionally-talented students. I think, in view of what follows, that it is important that you know my reasons.

The intellectual climate of any country is to a large extent determined by the extent to which excellence in human achievement is recognized, appreciated and, most importantly, encouraged and supported. Canada, to be true, is not exactly an intellectual wasteland, but many of our most promising younger citizens who move south, comprising our so-called "brain drain", do so (particularly in science and engineering) because it is evident that the intellectual pastures in the U.S. are definitely greener. Excellence, then, deserves support for its own sake (whether it be in art, skiing, science, or any other field of human endeavour).

Excellence also deserves support as a means to an end. In no field is this philosophy more relevant, and urgent, in Canada than in education. From many important sources (e.g. The Economical Council of Canada Report, The Bladen Commission on Higher Education) we are being told in no uncertain terms that however difficult it might be for economists to ascribe absolute values to it, education, including the fruits of new knowledge, is an absolutely decisive factor in the economic growth of Canada. Particularly is this true for science and engineering. That being the case, it seems to me that somewhere in the educational set-up there should be a system which singles out for special attention those persons who possess potential scientific promise..... those persons who are most likely to set the pace and provide the leadership, standards of excellence and initiative in the Canadian scientific enterprise. In short, we want to foster "excellence-at-the-top". The R.C.I. Summer Science Program has this as its chief aim.

The student whose quote I began this talk with was one of thirty-five grade 11 and 12 students chosen by competition from across Canada. The basis for selection was strictly academic, vis a vis ability to pay all or any part of either the tuition-board costs, which was $550 per student, or travel expenses. Last year more than 200 students had applied. The 23 boys and 12 girls selected represented nine provinces and the Northwest Territories. The students, therefore, were an elite group comprising without question some of Canada's future outstanding leaders in science and engineering.

Apart from being the only one of its kind in Canada* the program was unique in its own right. Most of the instructors hold senior positions in Canadian Science. Moreover, all are first-rate scientists, many with international reputations, and all are gifted teachers. Last summer's group of 27 instructors represented six universities, seven government agencies and two private industries. A new university with these people as its first staff would attain national recognition overnight. The program ran for six weeks - five weeks at the Lakefield Preparatory School near Peterborough, Ontario (a private school for boys during the regular academic year), the last week in Ottawa with the students living in residence on Carleton University's campus but working in laboratories of the National Research Council of Canada and the University of Ottawa in addition to Carleton University.

The program dealt with science in its broadest sense. For example, the areas discussed were philosophy, mathematics, biology, chemistry, geology, physics, experimental psychology and engineering sciences. The unifying theme lay in the design of the instruction. The aim was not to impart factual knowledge but rather to give the students a meaningful insight into what science is really all about. To many students, even the very bright ones, the essence of science is rote memorization, facility in manipulation of mathematical formulae, and wearing a white coat, to name only a few of the prevalent false assumptions. The true essence of science is discovery. The raison d'être of any scientist is to ask questions of nature and then try to answer them. Question-answering activities are, of course, not the special prerogative of scientists, but the kind of questions which can be asked and the way in which they are answered constitutes the so-called "scientific method" and in practise delimits science from other fields of human endeavour.

Not the facts of science then, but how facts are uncovered in science was the procedural keynote. All fields of science are amenable to this approach. For example in pure mathematics, the instructor had the students devise their own systems of algebra. Not surprisingly, the systems devised were for the most part a combination of crudity, triviality, and mathematical impurity - but that was one of the essential consequences of the exercise for in having their "discoveries" so assessed they learned a great deal about certain fundamental principles in mathematics, and in a way which will not soon be forgotten; and, most importantly, in having undertaken the exercise in the first place they were forced to recognize that mathematics is a lively discipline quite amenable to the experimental point of view.

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Summer Science Programs, similar to the one put on by the R.C.I., are well known in the U.S. Last year more than 200 such programs were sponsored by the National Science Foundation for more than 9,000 talented American secondary school students.

From the standpoint of the students, the benefits were manifold. The feeling of excitement and deep satisfaction which accompanies an independently-arrived at discovery, no matter how trivial or mundane, was shared by all -- but there were many other benefits. For example good science begins with an idea, not apparatus. One dramatic demonstration of this involved, after much argument and spirited discussion, a student-designed experiment to answer the question "what is the diameter of the earth?". As it turned out, the apparatus needed couldn't have been simpler -- plumb bobs, string, 2 x 4's, nails, watches, one car and a sunny day. Elaborate and expensive apparatus would merely have added a refinement to the measurements, not an improvement in the original idea. The students also had some apparently curious notions as to what scientists are like as people shattered. As one student wrote at the end, "scientists are human beings -- and pretty good one's at that". Also many were astonished to learn (evidently it had not occurred to them before) that if a person liked finding things out for himself, and was prepared to learn how to discipline his natural curiosity, then he could make his natural bent a career -- as a scientist. And of course many found their summer experience invaluable in their choice of university specialization. In the long run, however, perhaps the most important single benefit to the students was the way the program changed their approach to learning. Many comments by the students reflect this, of which my favourite is, "Thinking is an amazing experience". They learned that real understanding of any problem comes only from objective, critical, imaginative and precise thought -- and that this process is not at all easy. The rewards, however, are intoxicating -- a flash of insight, order suddenly replacing confusion, an increase in self-confidence. Students imbued with this approach to learning is unlikely ever to become engaged in second or third rate activities.

To date there have been three summer science programs, involving 102 students. We have been following with some interest their subsequent progress by questionnaires. Their replies have been most gratifying. All who are now eligible to go to university are there, and of this group more than 95% have chosen either Science or Engineering. On the average they have been awarded 1.7 major scholarships each. The best summarization of the consequence of their summer experience is the remarkable frequency with which such kinds of statements as "the Summer Science Program was the most exciting and important thing that has ever happened to me", appeared, unsolicited, penned on the margins of the questionnaire.

I am going to conclude with a mixture of anxiety and confidence. I said earlier that we need to foster excellence at the top in the scientific, enterprise. If you look at the present system you will find that encouragement and support of our promising young Canadians in this area does not begin until university and really reaches significant proportions only at the graduate school level. It seems to me that there are compelling reasons why we should set aside at least some of our financial resources for the support and encouragement of our potential leaders in Science and Engineering as soon as they can be identified. Surely the senior years at high school is not too early. The best example of the efficacy of this philosophy I can think of is our preeminence in hockey at the N.H.L. level where the owners of the teams realized a long time ago that elaborate (and expensive) farm system is the only way to guarantee a supply of Bobby Hulls and Jacques Laperrieres. Excellence at the top on a significant and continuing basis is attained by nurture, not neglect. What I am anxious about is that support for summer science programs like the one I have been describing may derive more from a "for motherhood -- against sin" attitude than from a true understanding of the very real needs of Canada in the changing times ahead. This year's R.C.I. summer science program was cancelled because of a $10,000 debt incurred by the previous programs and no prospects (last January) of the financial picture being any brighter for this summer. The R.C.I. has, however, committed itself to resume its special program in 1967. What I am confident about is the possiblity that the summer science program is now over the financial hump. The announcement of the suspension of this year's program had far-reaching and most gratifying repurcussions in both private industry and government circles. Evidently, there are in this country people in high places who believe, as do we, that Canada cannot afford not to support this kind of program. It is an investment, not a luxury.

# ENCOURAGING THE FUTURE SCIENTIST

by

Dr. Henry I. Bolker
President, Youth Science Foundation of Canada

I speak to you from what the modern literary intellectuals call "a position of total commitment". And my cause is this: if our country is to continue to prosper in a world evermore reliant on science and technology for its well-being, then we will surely need more and more scientists, engineers, and teachers of science in the years to come. Furthermore, if we are to have practitioners of the level of excellence we will require in these professions, then we must somehow show our young people that their elders - parents, teachers and the general community - all care about it, and all set a high value on the achievement of excellence.

That is my commitment, but, though committed, I am not a fanatic, and I shall not speak entirely from emotion. To show how scholarly I can be, I will support my arguments with appropriate recorded facts and quotations.

It is, of course, an old joke that to copy from one source is plagiarism; but to copy from more than one is scholarship. Nevertheless, in preparing this talk, I found that I could have made it up entirely of quotations from published studies, the general press, and other sources, and, without inserting a word of my own, without citing from the experience of the organization I represent, could have come to the same conclusions.

Let me begin with a quotation listing ten factors that are needed to produce interest in the student and to encourage him in the pursuit of excellence from childhood to maturity:

"....Interest of parents, early interest of the child, the commitment of school officials, good teachers and teaching programmes, maintenance of the student's interest through late adolescence, the student's choice of career, the university .... training, the family situation (in adulthood) ...., and professional assimilation and membership."

When these words were written, they were not intended to describe the education and life of a scientist. I took them, and only slightly modified, from a newspaper article entitled "A Shortage of Strings Worries North American Orchestras".1) It is surely not unrelated that the same period of history should produce apparent shortages of both scientists and musicians in North America, but that is a relationship I shall pass over and leave to some better-qualified student of the Affluent Society.

But the parallel breaks down when we consider that we applaud superior musicians from Russia, while we feel considerable apprehension over the achievements of her scientists and engineers.

It is perhaps an irony that science and technology, which have done so much to ease the physical burdens of North Americans, should have been relegated to a secondary position in the minds of its average citizens, and moved to the front place only after the traumatic day in October, 1957, when we discovered that the Russians could be more successful technologists than we. They beat us fair and square in sending up the first successful artificial sattelite, and since then there has been a "space race" - more suspenseful than a Roman Circus, and decidely more expensive.

This defeat, in 1957, led us North Americans to ask: is there something wrong with our educational system? Of course we should have asked the question years before, and without the kind of motivation that prompted it; but it is better to do the right thing for the wrong reason, than not to do it at all. In 1957, we suddenly began to ask why Johnny can't read and Ivan can, and we suddenly began to show great concern over impending shortages of scientists.

Indeed, we suddenly realized that we had long since needed some spur to create an interest in the study of science and to ensure that students who showed such interest were not discouraged by the contempt of their fellows who called them "eggheads" and "grinds", and who made heroes only of football players, while they made social lepers of those who strove for academic excellence.

At this time, too, amid the concern and talk about "shortages" of scientists, in the United States there appeared all sorts of programmes designed to alleviate them. From this side of the border it looked as if the sums of money the Americans were spending were astronomical.

Now, however, there are ominous signs that in the United States the honeymoon may be drawing to a close. Disregard the curious symptom that the U.S. television networks have lately begun to show football games simultaneously with launchings of manned satellites. Rather, note that this is the first year since the middle of 1950's that the U.S. federal budget does not contain a massive increase in total funds for research and development. 2) There has been no great reduction of funds, but certainly no increase. It is surely true that part of the reason for the abrupt change of pattern is the heavy expense of the war in Southeast Asia, but, also the mood and questions of congressional committees are such as to suggest some degree of disenchantment with science.

In our own country, as usual about ten years behind its neighbour, the big buildup of science has just begun. It was only a little over a year ago that the Prime Minister established a Science Secretariat. The promised Science Council does not yet even exist. However, for the second year in succession, the National Research Council is to receive a huge increase in its budget: it will rise 21 per cent from last year's figure of 71 million dollars, to a new high of 86 million dollars. 3) Only the Department of Defence Production, the Dominion Bureau of Statistics, the National Capital Commission and the Secretary of State have larger percentage increases than the N.R.C., and the last two are special cases because of the coming Centennial Year. Of these five items in the Federal Budget, the N.R.C. has the largest dollar increase.

Undoubtedly, a good deal of the increased budget at N.R.C. will be used to support the still-rapid growth of university research. In addition, the government has taken astonishing fiscal measures, mainly in the form of tax concessions, to encourage private industry to expand existing research and technical facilities and to build new ones. How are we going to provide staff for these programmes, and fill these laboratories? Well, I don't think that filling the laboratories with scientists - any old scientists - is really difficult. A good case can be made that there is no real shortage of scientists. The National Science Foundation of the United States has predicted that their country will actually have a surplus of 19,000 scientists for the whole period 1960-1970. 4)

Indeed, some scientists are becoming cynical about all this talk of shortage. Here are the words of one American:5)

"I have read many discussions on the 'shortage' of technical people and have concluded most of the anguish comes from the prospective employers who want to maintain a buyers' market for technical people, from the Government which needs technical people to beguile voters with moon racers and other buffoonery, and by educators who are trying to enlarge their empires and construct pipelines to the Washington mother lode of dollars and influence."

So much for the United States, but Canada, indeed, does have a very real shortage. However, it is not a shortage of scientists, but of engineers. Some figures were recently published on job offers to students graduating from the Department of Chemical Engineering at the University of British Columbia:6) in 1963 the average number of jobs offered to each student was 3.1, in 1964 it was 2.9, and in 1965 it was 4.7. The salaries offered reflected the shortage: the average offer increased from $446 per month in 1963 to $499 per month in 1965. Without searching for figures, I am fairly certain that a similar situation prevails in other fields of engineering.

On the other hand, also without any figures, I suspect that our country, like the United States, will soon have more scientists than it can accommodate, especially when a large part of the surplus Americans start spilling across our border. Yet there will be a shortage, and it will be a shortage of good scientists, with first-class ideas, and to keep the good scientists in Canada we will have to be prepared to give them the means to pursue their ideas.

I hope we will be able to do this, for we are so much the economic satellite of the United States, that we have to fight hard to overcome the branch-plant attitude that is common in our industries. Recently, an editor of the weekly news journal of the American Chemical Society made a dispassionate study of the Canadian Chemical industry, and reported that the ability of our foreign-owned or affiliated companies to draw on the vast research and engineering developments of their parents makes research here almost superfluous.7) He quoted one executive as saying:

"There's no point to spending money on research only to duplicate what is being done abroad. It's wasteful to do fragmented, half-hearted, small-scale research. Even if we were lucky enough to score a breakthrough somewhere along the line, we would end up having to exploit it elsewhere first because of the size of the Canadian market. For that matter, too, Canada's needs don't differ much from those in the U.S."

I am coming dangerously close to making the point that it may be a mistake to encourage young Canadians to adopt careers in science. But that is not the point at all. Rather, I cannot say forcibly enough that we still need the best scientists and teachers of science that we can produce. We also need to create an environment in which they will be able to engage in meaningful and productive work.

That is why eighteen scientific, techological and educational societies, including the Canadian Teachers' Federation, have banded together to see what can be done about raising the level of Canadian science, and of the teaching of science in Canada. For better for for worse, they chose to copy an American technique and encourage out-of-school activity in science by spreading the idea of science fairs in this country.

When so much is available in the classroom, why should there be a need for extracurricular science? I shall answer with a series of questions: why should there be extracurricular sports? extracurricular journalism (school newspapers and annuals)? extracurricular music? extracurricular dramatics? Because they are all part of the educational process -- all part of turning the student into a better citizen.

In this process, science fairs can play a special role as events where students with an interest in science can make a public presentation of their own private studies in some special subject. At the fairs, they compete against students of similar scientific interests, and the winners receive appropriate awards in the form of scholarships and other prizes of value. In this way, individual excellence is rewarded, and at the same time general interest is stimulated by competition. Even the students who do not compete learn something from the exertions of their fellows.

Let us be clear that the boys and girls participating in science fairs are not necessarily headed for careers as "scientists". Science fairs provide an outlet for constructive activity for young people, whether they ultimately become teachers, doctors, nurses, bankers, businessmen, farmers, government workers or engineers. The important thing is that the students have assigned themselves tasks, have been motivated to do their best, and have used their native talent and enthusiasm to demonstrate creative originality. Participation in science fairs requires self-discipline; it inspires the spirit of competition; it helps to establish contacts with adults who, as judges of exhibits or as spectators, can encourage youth to look to and beyond the completion of required school training.

One thing more -- lare or small, school and regional science fairs have this in common: the exhibition is viewed by parents, teachers and friends, and in this way some ideas and methods of science are passed on to the entire community.

We hope that the science projects at a fair convey the truth that science is not just a set of facts in a text book, but a living and expanding body of knowledge, to which we can all contribute: brilliantly if one is Einstein, spectacularly if one is the director of Cape Kennedy, more humbly, but still soundly, if one is serious and devoted and undertakes studies within one's means.

There is, of course, another side to this shiny coin. Science fairs have been operating long enough in the United States for faults to have appeared. An official of the American Association for the Advancement of Science has reported: 8)

" .... Sponsors -- and not all fairs are sponsored by educational organizations -- sometimes have a keener eye for publicity than they do for science. Some teachers make participation mandatory instead of voluntary."

"Children who are too young are encouraged to enter. A high grade in class may depend upon participation or be given as a reward for a winning entry. From these situations other faults flow. Gadgetry gets over-emphasized, and showmanship replaces scientific interest in the selection of projects. We have heard more than one student say, 'I'm really interested in __________, but this makes a better exhibit.' Emphasis on competition fosters a kind of intellectual dishonesty, the custom of having exhibits built by a parent or scientist friend instead of by the student. A few years a go a Washington, D.C. newspaper quoted a junior high school teacher was telling a student, 'You must go there and watch it being made; last semester some of the children didn't even get to see their projects until the week they were due.' Perhaps the teacher was not quoted with perfect accuracy, but science fairs do sometimes invite sponging on scientists. One scientist recently sent us a mimeographed letter he uses to avoid writing individual replies to the requests he receives from students, in particularly large numbers at science-fair time. In brief it says, 'No, I can't tell you all I know about marine biology; go to the library. No, I can't send you a collection of books and pamphlets or any specimens. No, I can't tell you how to design a project; that is up to you.'"

Let me hasten to add that the writer went on to describe the good features and results of student participation in science fairs. Nevertheless, Mr. Joseph H. Kraus, Co-ordinator of Science Fairs on behalf of Science Service, felt called upon to answer the criticism point by point, and he did so very very adequately.9) I don't think he really had to. Everyone knows that any human endeavour, however worthy, is open to abuse, and hence to criticism. The point is to be aware of the sources of abuse and eliminate them. We believe that we are doing this in Canada.

In addition, we have recently sent questionnaires to all former finalists at the Canada-Wide Science Fair. One of the questions asked that they state the benefits they felt from their participation. The answers include:

"It gave me the confidence to undertake other difficult jobs."

"It served to show my parents that I could handle my time efficiently without their control."

"It gave me a feeling of finally doing something successfully."

"It was a factor in helping me to get better summer jobs than I might otherwise have had."

"It made me study my subject more intensively than usual, and I found I had to understand it perfectly to be able to explain it to others. I feel this experience will help me prepare for my future career as a teacher."

"It made me aware of fields of science I had not encountered in the high school curriculum."

Let me add one thing more: in Quebec, and at the Canada-Wide Science Fair, French-speaking and English-speaking students are brought together in a common bilingual meeting-ground. I have observed, and heard comments, that the meeting was beneficial and enlightening to all. It is amusing to note that the Science Fairs Council, whose members do not judge a man by the language he speaks, insisted upon bilingualism even before the current fuss about it ever began. Perhaps in a small way, we contribute to Canadian unity.

Teachers are all aware of other ways of bringing science from outside the curriculum to those students who are most interested, and to those who can be led to develop an interest. The most titillating is a series of records called Singing Science Records.[10)] The title of the albums include "Space Songs", "Science Activity Songs", "Nature Songs" and "More Nature Songs", and "Weather Songs". I understand that by actual survey the most popular "hits" of the eighty-four individual songs are (in order):

1. "What is Gravity?"
2. "The Ballad of Sire Isaac Newton" and "Zoom a Little Zoom".
3. "Friction" and "What Is a Shooting Star?"

On the more serious side there is at least one programme of cooperation between a university and a high school, in which the university professors visit the school and lecture on some subject in depth;[11)] there is another programme in which high school students spend every Saturday morning at the university where they attend special lectures and work on directed projects;[12)] and there are also many lecture series sponsored by both universities and community groups. From what I have read about them, the lectures sponsored by the Royal Institution in London, England, seem to be the liveliest of all.[13)]

An interesting variation was the Connecticut Junior Science and Humanities Symposium held at Yale in 1964. I don't know if it was ever repeated, but I understand that it was very rewarding, both to the students and the people who organized it.

Along slightly different lines, the American Association for the Advancement of Science annually sponsors the "Junior Science Academy" at which the students themselves present scientific papers. The same is done in Canada, at least in Quebec, under the sponsorship of L'ACFAS, the French-Canadian Association for the Advancement of Science.

Within the schools themselves, there have almost always been some science clubs, and they often invite professional scientists as lecturers. In Canada, such clubs are usually affiliated with and get their inspiration from organizations like the Science Clubs of America, and the Future Scientists of America. No wonder we have a "brain drain"!

Television programmes of good quality are also a worthwhile stimulus for students. Such programmes have been of several types. One is the lecture-demonstration, considerably enlivened by wit and imagination. We can fairly claim to have had some of the best of these in Canada. Another programme is the kind in which youngsters themselves participate, sometimes to play the part of naive questioner, sometimes to act as the expositor, and sometimes,[14)] as in Midland, Michigan, to participate in a Science Quiz. Sarnia, Ontario, has had a Science Quiz on the radio.[15,16)]

There are also summer camps which specialize in science. There are many in the United States. There has been one in Ontario, and two or three in Quebec. In the United States, such camps are easily financed, at least in large part, by funds from the National Science Foundation. In Canada, the camps can obtain no such financial help, and they either struggle along on a hand-to-mouth basis, or they founder.

Another stimulus to science education in Canada comes from the competitive out-of-school examinations in mathematics, sponsored by the Canadian Mathematical Congress and by some Teachers' Associations, and in physics, sponsored by the Canadian Association of Physicists.

Finally, I should mention the excellent publications that can be used not only as extracurricular material, but also as teaching aids. As usual, in English-speaking Canada, we have to use the publications from other countries, Britain and the United States. Our French-speaking compatriots are more fortunate: they have their own first-class science journal for high school students - Le Jeune Scientifique. They have even reversed the usual pattern by having subscribers in France and Belgium.

This is an appropriate point to mention that the Canadian Science Fairs Council is taking steps to fill the gap on the English-language side. We are nearing completion of a study to determine the financial feasibility of a Canadian Science publication for high school students, and, at the moment, all the signs look favourable. We know that all of our member societies are behind us and will cooperate, and are certain that many of the most prominent and articulate scientists and teachers in Canada will contribute all the articles we need. We believe that we can create a Canadian journal we will all be proud of, and that it will become a powerful weapon in the struggle for excellence.

The creation of the new journal is but one manifestation of the Council's desire to improve the base it stands on. It may have been hasty in the first place for this country to have plunged into science fairs activity without having laid some groundwork. Now we are doing what Arthur Koestler, the novelist, who is also a medical man, described in a lecture called "Biological and Mental Evolution" as "reculer pour mieux sauter"17) - which I think is translatable into idiomatic English as "taking a few steps back so that we can get a better run at it."

Not only are we going to try to publish this journal, but, with the blessings and cooperation of the organizations involved, we are also going to make some attempt to coordinate the other out-of-school activities, such as the mathematics examinations and the summer camps, so that all may work to mutual advantage. Not the least of our objectives is to try to see that the time of neither teachers nor students is unduly encroached upon. Also, we feel that some coordination may help in financing these activities.

In line with these changes of policy, the Council is also changing its name: in future it will be known as the Youth Science Foundation - Foundation Sciences-Jeunesse.

I have just mentioned finances. At the moment, the Council itself is in good financial condition. But a year or so ago, our organization nearly died for want of funds. The Royal Canadian Institute Summer Science Programme is in financial trouble. Le Jeune Scientifique runs a considerable annual deficit. L'Association des Jeunes Scientifiques is short of funds, and so is Les Jeunes Naturalistes. These organizations have all been relying on donations from industry for their sustenance.

But industry is letting them down. Clearly, industry in Canada doesn't know which side its bread is buttered on. Its spokemen speak fine words.

The newspapers have quoted a former president of the Canadian Manufacturers' Association as calling for intensified efforts by Canadian industry to help better the country's education position.18)

Let me also cite on George Hees, famous, I believe, as a professional football player who rose to be president of the Montreal Stock Exchange. I am told he now has other aspirations. Mr. Hees said very recently19) that Canada must increase aid for scientific education and businessmen must take a leading role in the move. Industry, he said, must consider its share of education costs "as one of their costs of production".

These can be nothing but empty sounds when organizations of the kind I have described must go begging. Even when we have pointed out to some firms that they ought to give financial support as a matter of self-interest -- that if they considered the economics of future supply and demand for technical personnel, they would see that an increased supply would keep salaries from rising -- they did not respond.

Compare and contrast these two situations:

The Canadian Science Fairs Council, a national organization, requires 25,000-30,000 dollars a year in order to do its job. It has never raised more than 14,000 dollars through solicitation of the largest industries in Canada.

In the United States, in one city alone, the city of Chicago, the local science fair awards $35,000 each year in scholarships.20) The amount it spends on administration and organization must be another 10 to 15 thousand dollars. All of this money is collected from industry only in the greater Chicago area.

I don't suppose I need assemble and cite figures for other American cities and for the American national organization to drive my point home.

Well, if industry in Canada is not wise enough to help, what about Government? The answer is that we live in a country hampered by its own constitution. In other countries governments can and do act to provide financial help for organizations that foster the spread of scientific excellence by out-of-school activities. In Canada, the Federal Government must keep away from anything that remotely concerns secondary education: the Provincial Governments will have nothing to do with a national organization.

Again, the can give us fine words, like the Federal Minister who, on officiating at the opening of a regional science fair, praised the science fairs for what they are doing, mentioned the connection with Canada's need for scientists and techologists, and said that "Your Federal Government is very much aware ...."

That same Federal Government, with no power to act in or near the vital field of secondary education -- that part of education where ambitions are formed and careers are determined -- does, on the other hand, find it constitutionally possible to give a grant of $18,000 to the National Ski team for travelling and living expenses abroad.21)

I would like to plead somehow, somewhere, but I know not where, that surely, though some provinces may wish to teach history, or languages or religion differently from the others, at least in the field of science, which is the same for all, they should make it possible to work together. We need to do this not only to support out-of-school activities on a national scale, but also for such purposes as the re-training of science teachers. Unlike the other subjects I have mentioned, where the methods of teaching may vary, but the subject matter does not, the subject matter of science changes so rapidly that many of us who left school ten to twenty years ago are out-of-date several times over. By the introduction of large national re-training programmes we could achieve an economy of scale in their execution.

As to the provinces, they will not consider a cooperative programme of support for out-of-school science activities, although some of them do give support on a regional basis.

But in general, the provinces, too, fail to match their deeds to their words. Recommendation No. 266 of the Parent Commission Report encourages support of scientific associations for young people; and specifies young naturalists, scientists, 4-H Clubs, etc.

Yet when the *Association des Jeunes Scientifiques* (Association of Young Scientists) recently asked the Quebec Department of Education for 1,500 dollars to meet their deficit, the only reply was an example of adroit buck-passing. The president of the association, obviously a hot-blooded and impetuous young man, reacted in a way I would often have liked to, but I would never get away with it. He called a press conference in which he told the reporters how the Department had refused to help, then he said some of the nastiest things he could think of. Among them he referred to one senior official by name and said he was "a mere technocrat who can see no further than the limits of the wall-to-wall carpeting in his office".[27]

Considering his youth, that young man will surely be forgiven. But, as I said, *I* would never get away with this sort of thing. In fact, if you or I called a press conference, no reporters would even bother to come.

Perhaps all this means that the scientists and teachers are wrong, and if both industry and government cannot or will not support us, we should stop wasting our energies in directions that lead only to frustration. We should say: a plague on all their houses!

But we are committed people. We must act on what we know: our high school students of today will be adults very soon. Whether or not government and industry will help us, it is up to us to see that these students develop a will to the achievement of excellence, up to and beyond the limits of their capacities.

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# THE PRE-SERVICE EDUCATION OF THE SCIENCE TEACHER

by

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In the past, we science teachers have been trained by completing courses in science deemed necessary as a background for the science we would teach in the secondary school. These were profitable courses indeed: and we, as potential teachers, studied them and mastered them. Having done so, we believed at that time we had learned once and forever, all the science needed to carry on our chosen profession of teaching. We followed the required courses in pedagogy, after or before taking the science courses....did our practice teaching....and received permanent certification as teachers in the secondary schools. We did not feel any necessity for further study of science.

Suddenly, we discovered that our teaching in the traditional sciences did not provide us with the knowledge necessary for teaching a "contemporary program of science instruction". Universities across the country, during their summer sessions, came to our aid with re-training courses in the newer aspects of the branches of chemistry, physics and biology. These courses are gaining popularity....and, they are being mastered by teachers to enable them to teach the new programs proposed for the secondary school. I understand, however, most of these new programs are presented by the universities in the same old way, as something to be learned, and the teacher is again supposed to know all that is necessary to teach the science courses of the future. This, as past experience has taught us, cannot be the case.

In this day and age, much is being said about improving the qualifications of science teachers. In the province I represent, New Brunswick, more emphasis, at the graduate level, is placed on the B. Ed. and M. Ed. programs than on programs in the teaching of science subjects. I personally feel that these programs are ideal for future administrators, but are not meeting the needs of science teachers. Evidently, it is assumed that the full requirements to teach science in the academic high school is a B.A. or a B. Sc. with a major in the branch of science to be taught.

In the U.S.A. during the last decade, comments about science teachers with this type of educational background prompted this statement: "These qualifications are a good indication that the prospective teacher knows a great deal about science, but is no guarantee that he knows what science is about." This statement was confirmed as fact by Frances Behnke in a survey conducted in 1961, "Reactions of Scientists and Science Teachers to Statements Bearing on Certain Aspects of Science and Science Teaching."

Professor Howard Fehr, Mathematics Department Chairman of Teachers' College, Columbia University, suggested an alternative method, in an address at the International Working Session on "New Methods in the Teaching of Mathematics" held in Athens, Greece, on November 17 to 23, 1963. His comments on the training and re-training of teachers of mathematics could very well apply to the training and re-training of teachers of science. Professor Fehr suggested that "we must now educate our teachers in how to educate themselves, how to continue to study and learn more and more newly emerging mathematics and mathematical concepts. This means the teacher is always to think and act as a student who is aiming to be a little of a researcher all of his professional career. This training should certainly be established in the last years of university study, and should become the primary goal in the pedagogical training the teacher undergoes before and during his apprenticeship. The study of mathematics never ends and new mathematics creations go on and on forever!"

He also suggested in his address that if this type of education were successful, there would be great need for a new kind of textbook....one of self-study by teachers in service, that these books should appear from time to time, that they should always contain something new, or at least, an entirely new approach to something already known.

Evidently, more science and mathematics educators in the U.S.A felt that the answer to better teaching of science could be found in research, because in research lies the best opportunity for the person who knows about science to learn what science is about. The National Science Foundation supported two programs. First: A teacher-centered program in which selected teachers were placed in the laboratory beside the research scientist proved not successful, because teachers tended to return to the same pattern of teaching after the re-training was completed; and second: A school-centered research experience for science teachers, under the direction of Cornell University, has been described in "The Science Teacher", Vol. 30, No. 5, September, 1963, by Mathew H. Bruce, Jr., and Philip G. Johnson, Science Education Division, Cornell University, Ithaca, New York.

In this second program, selected high school science teachers carried on scientific research in their school situations, involving science-oriented students as laboratory assistants, working underthe guidance of a research scientist. Some of the conclusions are as follows: (1) "Valid research can be carried on at the teacher's level in the high school situation, although care in the matching of teacher and scientist and in the selection of a problem is a vital factor here; (2) Responses from all three participating groups indicate in a subjective fashion that both teachers and students increased in their understanding of science as a process of inquiry as a result of their participation. Furthermore, the results of the evaluation suggest that the effect of the presence of the program in a given school upon non-participating students is a discernibly positive one."

It would be very short-sighted to think of pre-service education in the teaching of science as totally a post-high school program. Novice teachers, in general, will use techniques and skills acquired from their former teachers. We teachers of science must realize that habits, attitudes and ideals formed during the high school years are lasting ones. This is the time to foster an eagerness to learn, and to keep on learning, to encourage a willingness to change one's work habits, and to develop a sense of responsibility.

Could it not be that some of our high school students, who possess the creativity necessary to be future teachers of science, do not become teachers because they are aware of the restraints in our curriculum? As our students, they know we are told what to teach and when to teach it. These young people, endowed with the enviable qualities teachers of science of the future should possess, do not want to be straight-jacketed by curriculum and supervisory restrictions. Individuals of this calibre have self-direction, want the "most for their money" so called, have a good sense of values, and, above all, want their chosen career to be a professional challenge rather than an accumulation of knowledge. Thus, the re-training of the teacher of science not only affects the teacher, but even more directly, concerns the science student, whose development in our field of work is the reason we became teachers.

We teachers are being challenged by change. We must accept, as our responsibility and duty, the task of finding out the nature of this change and how we are to respond to it. I suggest that the training and re-training of science teachers should become the prime concern of a National Science Association of professors of science education, scientists and secondary school teachers, who are concerned with keeping themselves informed by continuous study through available literature of an appropriate kind. Through the media of conventions and publications, geared for the high school teacher, professionalism would be developed at all levels....through the affiliates as well as through the national association.

My remarks contain no steadfast recipe for "Pre-Service Education". This should not be surprising because I have had no formal pre-service training, if that is what is meant by "Pre-Service Education". But what I particularly do like is the philosophy of student and teacher working and thinking together. I sometimes learn from my students. I hope they often learn from me.

From my remarks we could probably find a basis for discussion, and possible answers to these questions:

(1) Could it not be that training in a more creative approach to teaching, in the fields of science and mathematics, would attract more capable young graduates?

(2) If the science teacher of the future were involved in the creative activities of research during his high school career, would he not be better prepared to meet the challenges of change?

(3) With the creative approach to teaching, would our science students not be better prepared to make an intelligent choice in one of the scientific careers which could include the teaching of science?

# REMARKS ON THE PRESERVICE EDUCATION OF SCIENCE TEACHERS

by

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It seems to me that a member of this panel should first take a critical look at the current practices in the preservice education of science teachers in Canada, and then propose some guide lines or models for improving upon these practices. This is what I intend to do. As might be expected, most of my criticism will be directed, not at teacher educators, but at those science teachers and instructors of science who participate in the teacher education program. Since some of my remarks might be harsh, let me say in advance that I share the total brunt of my own criticism, for I speak as a science teacher and a university science instructor as well as a professor of education.

The prevailing curricula for teacher education in most Canadian institutions fit into the following pattern:

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| General courses: e.g., English, philosophy, history, etc. | Courses in the subject major: e.g., physics chemistry, etc. | Professional courses: e.g., curriculum and instruction ("methods"), ed. psych., ed. phil., etc. | Student teaching practicum, internship |

Programming and administrative control is generally in the hands of the Faculty or College of Education. However, the courses, apart from the professional ones, are taught in other faculties or departments, while selected teachers in the field participate in the practical phase of the teacher-training program. Both the curriculum itself and the quality of training it provides, have been the object of scathing criticism, the most recent and thorough being that of Koerner and Conant. The bulk of the criticism has been directed at the professional (i.e., "education") courses with the so-called "methods" courses receiving heavy share. I need not repeat here the choice words of derision and ridicule used, and I am sure many of you have some pet ones of your own. I do not deny the low quality and perhaps worthlessness of many of the education courses (past and present), nor the need for a drastic revision of teacher education practices. I am bothered, however, that those science teachers and professors of science who participate in the training of teachers have managed even to this very day to escape from their fair share of criticism. I believe it is high time that some of those who have been critics of the Faculties and Colleges of Education become targets of criticism themselves!

First, let us examine the science courses taken by those of you who are now science teachers, during your years of professional training. Were these courses always up-to-date, and geared for the kind of science you would have to teach in your own classroom? And how were these courses taught? How many of you were taught physics, chemistry, botany, etc. in the manner now being advocated for CHEM Study, BSCS biology, PSSC junior high physical science, AAAS elementary science and so forth? And was your laboratory work inquiry-oriented and correlated adequately with the lecture theory? Yet it is these preparative courses which are valued so highly when science teachers are surveyed. However, in my opinion the science courses which you took at the university or college generally provided a poor background, both in content and methodology, for the kind of science you are now expected to teach. I might add that the current situation in these science courses is not much better than when you attended, and that it spills over into most in-service courses in science.

The lack of an investigative spirit in the content and laboratory work in university science courses has left an indelible imprint on the science teacher's philosophy and method of teaching. It is said that teachers tend to teach as they were taught. If this is true, then it is not surprising that in a recent survey conducted by one of my graduate students it was found high school chemistry teachers believed "verification" of scientific principles to be a most important purpose of laboratory work, and deemed the "lecture-demonstration-laboratory" and "lecture-demonstration" combinations to be the most effective for teaching science. Undoubtedly, this attitude is one reason for the considerable opposition to inquiry and laboratory-oriented science teaching. Truly then, here is a major problem of re-orientation and re-education to be coped with in in-service or continuing professional education programs.

It is possible to push this criticism of university and college science further, but let us turn our attention to the teachers who participate in the pre-service education program. Now, let me back up one step. Let me ask the question: How many science teachers are anxious to participate? Many do come forth, but where teachers can "opt out" (as they can in Alberta), the participation of many of the best teachers is lost. This poses a serious problem in my work. I want my student-teachers to gain maximum benefit from their practical experiences in the classroom. Here at this conference we have heard much about the new science programs. Yet, I can find very few science teachers where my students can see science taught in a spirit of inquiry. I am mindful of the difficulties facing the already overburdened cooperating teacher or teaching associate, and recognize that the Faculties or Colleges of Education are not rectifying the situation with the desired speed. However, if teachers teach as they observe others teach, then the practicum or student teaching may be actually harming many of my students.

My major point, then, is that all parties concerned with the teacher education process have failed to some degree. This sad state of affairs is overshadowed only by its consequences for the consumers of our science teaching -- the children whom we teach!

Obviously, a massive overhaul of the pre-service education curriculum and practices is called for. Time does not permit me to develop a comprehensive model but here are some guide lines which I deem highly important and which should be of concern to this conference:

1. The preparation of teachers for all grade levels must take place in the intellectual atmosphere of a univeristy.

2. It must be a joint responsibility of university personnel and associated members of the teaching profession.

3. The features of the curriculum outlined above should remain, but the nature, proportions, quality and sequence of the "mix" should be continually revised, tested and evaluated. I might add, parenthetically, that evidence is accumulating against an increased emphasis on subject matter competence.

4. The dichotomies between theory and practice, and between precept and concept must diminish continually, for in both instances the one can thrive and flourish only upon the other. This dictum should be the guide line for all who participate: the associated science teacher, the professor of science, and the professor of education.

These and other guide lines point to a pre-service education for our future science teachers which will be the most fruitful meld of the best of the following ingredients: The structure of the sciences (i.e., their content and mode of inquiry), the nature of the learner and the learning process, the theory and practice of science teaching, and the grand vision of the schools of the 70's or 80's, or even of the twenty-first century.. The participants at this conference and the organizations which they represent must help catalyze and achieve this desired goal.

# THE EDUCATION OF THE SCIENCE TEACHER

by

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If education is a problem of major concern today, and few would dispute this suggestion, then education of educators is proportionately more important. This process of educating the educators, while a pressing problem, is one which is subject to a great many demands which seems to be self-contradictory. We need far more teachers, but they must be better trained. The teachers need advanced training, but must not be specialists. The teachers must keep abreast of their subjects, but must not spend any time doing so. And so on. The result of this is that educational authorities disagree widely as to what constitutes proper teacher training. Many feel, and I am among them, that extensive teacher-training courses should be abolished. In fact, the main reason that I am not today a high school teacher is that I took a teacher training course.

It would be presumptuous of me to try to solve such a complex and far-reaching problem in a few minutes. Thus, I shall speak somewhat more generally about education, in the hope that in the end my remarks will have illuminated at least part of the problem at hand.

It seems useful to start by describing what are, in my view, the important objectives of high school teaching in a particular subject. Once again, it is absurd to attempt this briefly, but I hope that my brevity will not be interpreted as narrowness, and that my failure to expound on a topic will not be construed as disregard of its importance. I feel that the main objectives in the teaching of any individual subject are the following, which are approximately in order of decreasing importance when considered for the Sciences:

1. To engender in the student a lasting interest in and respect for the subject as a field of human endeavour.

2. To arouse in some students a greater interest, which impells them to pursue advanced study in this field.

3. To impart some knowledge and skills which are of themselves useful.

Unfortunately, the ease with which these goals may be achieved is in the reverse order, and it is because of this fact that the teacher as a live human being must never be replaced by the teaching machine. One can easily master, and transfer to the students' notebooks, and in turn to their examination papers, the specified facts, and even the approved principles. Indeed, one is tempted to suspect that the syllabus in many a subject is created with exactly this in mind. But who is really seriously concerned with memorizing the Frasch process, the formula for superphosphate of lime, or the electrochemical series?

To excite students about a subject requires being excited oneself. It requires a fascination not only with the facts but with the ordering and interpreting of facts, and indeed with the very impossibility of clearly and simply explaining all the facts. It requires the considerable depth of study which enables one to perceive apparently anomalous phenomena and wish to understand them; that for example, the chemical process which leads to the production of the Canadian five cent piece apparently violates the electrochemical series, but doesn't really because some other principles apply.

It is clear that the proper teaching of a subject requires much more than superficial familiarity with a few textbooks. It requires the teacher to be thoroughly educated in his subject, and to maintain touch with developments occurring every day. Above all, his interest must remain alive. That the present qualifications of teachers in the Sciences are often far below a satisfactory level is revealed by various recent studies. Current studies by the Chemical Institute of Canada are showing that a substantial fraction of the Chemistry teachers in each of the Canadian provinces have had little or no formal training in Chemistry at university.

The first and most important objective is even more difficult to impart, and requires not only a knowledge of the subject at hand but also a considerable knowledge of other related subjects and the history of their development, and a perspective over the place of one's own subject in the development of modern society. This is, of course, an impossibly large order, and one cannot expect that many high school teachers, or university professors for that matter, will meet this requirement. However, the student must never be left with any doubts as to whether this subject is worth the trouble to study it. If the student asks seriously "Why would anyone bother to study Chemistry?" then the teacher has failed. This failure doesn't receive much attention, because it is so difficult to measure and even to define.

There is one other goal which could well be inserted here, which is not related so much to Science teaching as to teaching on a whole. That is, that a respect should be created for the teaching profession. It is depressing to reflect on how few students come to university to become science teachers. Many have burning desires to become doctors, dentists, engineers, and so on, but teachers -- no. This is in spite of the fact that most students have much respect for many of their teachers as individuals. This, I feel, cannot be construed as a criticism of teachers, but of the situation which surrounds teachers, which forms a large part of the impression given to the students. This is one more endless loop in our ever growing Gordian Knot.

Before I describe the kind of education I should like the science teachers to have, I wish to mention one prime requirement without which no Science teacher can be successful. The teacher, the teacher of any subject, but particularly the teacher of Science subjects must be truly articulate in the English language (or the French language). His speaking and writing must be crystal clear, with good grammar and a good vocabulary. English composition need not be a subject in high school -- it ought to be exemplified everywhere, and watched carefully by all teachers. This is particularly important, I feel, in the Sciences. Elegant style is, of course, unimportant, but correctness and conciseness are essential.

The details of any education program are, of course, subject to a great deal of argument, on both academic and practical grounds. Thus, it makes no sense for me to attempt to prescribe a course of study, or even suggest minimum requirements. I shall, however, venture to make some rather general recommendations:

Firstly, the prospective teacher of any Science subject must have good grounding in his field, Inescapably, this means several courses at university, with good standing. It is not necessary, in my view, to have an advanced degree in the subject, nor even an honours degree, since this type of degree usually produces far too specialized a graduate, whose interests are seldom appropriate for high school teaching. We must, after all, recognize that the high school teacher is a professional teacher not a professional scientist. He must, on the other hand, have obtained good training both in his main subject and in all ancillary and related subjects.

Secondly, the teacher must be encouraged -- indeed expected -- to keep up a lively interest in his subject. This is, of course, very easy to say, but very difficult to carry out, since it involves giving the teacher much more free time than is at present possible, and it means resisting all encroachments on this time from extra-curricular activities and administrative chores. The teacher must have time to read such things as the Scientific American -- his best pupils do. He must have time to read in the technical literature far beyond his schoolwork. He must have time to go to scientific meetings. Some people urge that teachers be required to take full-year leave occasionally, to go back to university. And, most important of all, he must be given tangible recognition of these efforts. He should receive as much credit for updating courses, professional development courses, summer laboratory jobs, as for courses leading to graduate degrees. An important result of this requirement is that the high school teacher must never be asked to teach a subject other than that of his main interest. Thus the Chemistry teacher who also teaches Biology and Algebra ought to be a thing of the past.

Thirdly, the syllabus must be relieved of pressure, so as to allow the teacher time to show his interest in his subject. The teacher who has a pet interest in some special branch of his subject must, at present, suppress his interest, and get on with the syllabus. After all, the exam will only cover the syllabus. This one aspect of present-day education, if no other, will act to snuff out the interest that the teacher may once have had in his subject. If luck is on his side, his interest will die slowly. If, on the other hand, the teacher is allowed to indulge his fancy, then at least that part of the course, and probably much more, will be taught with all the enthusiasm the teacher has, to the benefit of all.

I have carefully avoided discussion of "Teacher Training" courses, partly because I am in the presence of others much more qualified to comment than I, and partly because I suspect that my own opinions may be tinged with a measure of bias. I do wish, however, to express my fear that the results of this training are not always the production of a better teacher. I feel that the best way to bring out the best in a potential teacher is to subject him to an apprenticeship under an excellent, experienced teacher.

One might continue for quite a long time discussing the ills of the system. I think however, that the few points which I have expressed are by far the most important. I know that many counter arguments can be raised, especially those pointing out practical difficulties. Perhaps the most urgent practical problem is that of money -- not for teachers' salaries but for providing more, many more, teachers and also for facilities such as school laboratories. Here I am talking of many millions of dollars, which is of course a formidable obstacle for any plan to encounter. I am sure, however, that you, perhaps more than I, recognize the seriousness of the situation, and agree that the time is near when we must take drastic and courageous steps to save our education.

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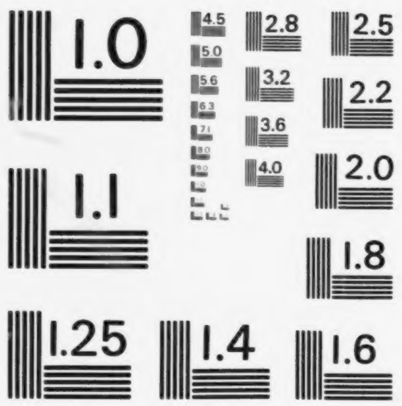
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# THE INSERVICE EDUCATION OF THE SCIENCE TEACHER

by

R. A. Piercy, President
British Columbia Science Teachers' Association
of the BCTF

(Note: This is a summary of the talk given by Mr. Piercy)

## What need is there for inservice education?

There is no doubt as to the need, because of the rapid series of changes that take place in science courses in schools (e.g. Chem Study, P.S.S.C., etc.), and because of the rate of increase in knowledge and the development of new approaches to old topics.

## Who is responsible for the re-training of teachers?

Is inservice training primarily the responsibility of the teacher, the teachers' specialist association or provincial organization, the school board, the provincial department of education, the universities or colleges of education, industry, or (either as an alternative or in addition to any of these) the federal government?

All of these should be concerned with the problem, as they are all affected in one way or another. However, it is the special responsibility of the school board and of the provincial government to see that children are educated properly. These two bodies have responsibility to the community, and are the employers of the teachers.

There are parallels in industry. For example, the community expects the telephone company to have properly trained personnel, and the telephone company accordingly arranges its own inservice program during working hours, for technicians, computer operators, engineers and so on. (In B.C., these programs cost the company more than $100,000 a year, without taking account of wages paid to those undergoing training.)

## What do school boards do?

Very seldom do they set up inservice programs within their area. In British Columbia, the only board-sponsored courses which come to mind are some evening courses operated by the Vancouver School Board in Chem Study and P.S.S.C. Physics. Boards may often allow time off if a teacher wants to attend a conference organized by some other agency -- but the number of days allowed is often limited to two per year. In the matter of initiating, organizing and financing inservice courses, neither the school boards nor the department of education are noticeably active.

One of the things that school boards and departments of education are doing towards encouraging inservice training is giving entitlement to higher salaries to those who obtain more degrees. Too often, however, the courses which lead to higher degrees are not really of much use to the teacher in the classroom in regard to the new courses which are being introduced into the school curriculum.

What are the teachers' organizations doing?

This depends on the enthusiasm and direction of the organization. In B.C., the Science Teachers' Association helps to provide speakers for conventions, workshops, etc., and advises the provincial organization as to the need for inservice training. The provincial organization subsidizes workshops, and sets up two-week summer inservice courses wherever there is a need. This summer there will be six or eight of these summer programs operating in various parts of British Columbia.

The provincial organization also advises the university as to the need for longer and more specialized courses -- for example, five-week courses in Chem Study, up-dating courses for science teachers, etc.

Perhaps the main function of the teachers' associations is to see that courses are made available by some appropriate agency whenever there is a need.

What is expected of the teacher?

I think that the teacher should be expected to keep himself up to date in his own field, and to attend, in his own time, whatever courses are necessary for this purpose. Absences from teaching for attendance at short (1 or 2 day) sessions are not objectionable, but generally the nature of the job of teaching requires the continuity of one person's presence, with as few interruptions as possible. However, one has to be realistic in one's approach to this problem, and the teacher needs some inducement -- the proverbial carrot -- which could be one of the following:

a) Expenses (books and tuition) paid for by the school board;

b) Entitlement, on completion of the course, to a higher qualification rating and therefore a higher salary;

c) Time off from school to attend courses.

The policy of awarding permanent higher qualifications or certificates on completion of three or four courses (often university summer courses) needs to be very carefully examined. Years after the usefulness of these courses has been lost through obsolescence, the certificates awarded will still be costing education authorities in the form of extra pay.

I think that teachers who are willing to take five-week summer courses should have their zeal, and their higher academic qualification, recognized by being placed on a higher salary scale, but that the following conditions should be attached to increases in salary:

a) The courses should be related to subjects which the teacher teaches;

b) Salary increases should be limited to five years from the time of completing the course, and should then lapse if the teacher has not taken a new course.

By this means, the teacher would be rewarded for making an effort to keep up to date, and at the same time would not be paid on the basis of a course which he took twenty years previously. Such a plan would give teachers a strong inducement to keep up to date.

In conclusion, I would like to repeat that the school boards are not doing their share in seeing that their teachers are kept up to date, and that the reward system for teachers who take extra training needs to be revised so that a teacher is adequately rewarded to all his efforts and always has before him an inducement to further improvement.

# THE IN-SERVICE EDUCATION OF THE SCIENCE TEACHER

by

Robert C. Stone,
Chairman, Scarborough Board
of Education

Before I begin this short talk, may I say how privileged I feel to have some part in this important Conference. I believe that I was propelled into this job due to the machinations of one of our top history specialists, Mr. James Lovekin, a Historian I am afraid who has taken a leaf out of Beatrice and Sidney Webb's tactics of infiltration. But then, just where is the dividing line between the student of history and the student of political science?

During the course of this Conference we have heard a great deal about change in curricula and its implications for teachers in the classroom. These changes represent an opportunity which all of us who are engaged in education ought to recognize as an opportunity to grow in effectiveness. Too often, the swiftness of technological change harnessed to state-induced economic growth, may at times lead to a feeling of despair that public education, notoriously a follower rather than a leader in accepting new concepts, may never catch up. But catch up we must!

Certainly the opportunity appears to be there because of the general acceptance by the profession and media of communication which communicates between the profession and the public, that in so far as science, technical and vocational education is concerned, continuous updating is required and expected of us. Without it, accelerating educational expenditures are meaningless.

What is not so generally recognized however, or if it is, it is only in vague terms, is that teaching staff must also be continuously updated and indeed, upgraded, in order to cope with a situation which got out of hand a long time ago.

Let me tell you how my Board is attempting to cope with the problem. First a little about ourselves: Scarborough has the third largest student enrollment in Ontario and the 7th largest in Canada. The Secondary School System is expanding at the rate of two, twelve hundred student schools per annum. This year's capital programme is equivalent to 1/5th of the entire 1966 school building estimates for the Province of Ontario. We are rich in children and poor in real estate assessment. You may imagine the pace at which decision-making and events spurs us forward. Just to acquire the teachers for new classroom, plus replacements is a major operation in itself. On top of this impose Ontario's revised Secondary School programme and an apparently limitless flow of memoranda to School Boards gushing forth from a hitherto somnolent Ministry of Education, and the stage was set for useful evolution.

In Scarborough we have made a beginning due primarily to the establishment of a means of discussion and consultation between teachers and the Board outside of the annual mutual irritation conference, teachers' salary negotiations. We established a Teacher Board Liaison Committee. This is not the place to expand on this useful device other than to enlarge on part of the outcome of rather infrequent meetings to date.

Our teachers, recognizing the alterations in mathematics, physics and chemistry curricula, development of data processing and the need to keep vocational teachers abreast of industry, requested the Board to provide funds so that teachers could attend useful courses and lectures in mid-term in specific subject areas.

The Board accepted this recommendation unanimously and allocated $10,000 in 1965 to encourage secondary school teachers to keep up-to-date with particular subject areas. The ease with which this recommendation was accepted by the Board was due, I think, to two reasons. First of all, the Board had long since established in-service training in the Public School System because of heavy turnover in teaching staff among Public School teachers and an exceedingly low level of experience. It wasn't a very large step at all to extend a variation of this programme to the Secondary School staff. But aside from the proven utility of past experience, there was the example of industry. Just the other day, I was listening to Mr. McCormack, President of Dominion Stores, speaking to the Toronto Society of Financial Analysts on the prospects for this particular company. During the course of his address, he said that each year a group of key people in his company are directed to University Management Courses. In the past year, more than 100 have attended various courses, seminars and conferences, to broaden their knowledge. Practically all that particular company's store managers and supervisors have attended Management Workshops during the past year. Fifteen of his people are working towards degrees in accountancy with financial assistance from the company, and 600 of his personnel are enrolled in correspondence courses in marketing.

Surely it is easier for School Boards to implement up-dating programmes which parallel similar activities in industry and commerce. The problem of who should avail themselves of such courses is enormously simplified.

As to the allocation of this initial $10,000 the Board did make one stipulation: the courses were to be used for up-dating as distinct from up-grading. Expenditures were made after discussion and consultation between the various subject Chairmen and the Board's executive staff on specific programmes available.

Many requests were made to take courses and to invite outstanding lecturers to address groups. When these speakers visited Scarborough, graduating students and in some cases, outstanding students in various grades were invited to attend the lectures. Teachers in science and mathematics were most active in participating in this plan.

In the mathematics field, a special course was organized for commercial and maths teachers who were interested in data processing, a course which is under continuous development in Scarborough. Thirteen teachers attended a special Series given by Scarborough College, a satellite college of the University of Toronto, at a cost of $105 per teacher. The fee was paid by the Board. In addition, an Enrichment Course was given for gifted students in mathematics in which the majority of our maths specialists attended or participated. This was a 12-week Lecture Series which covered the following subjects: Logic, Diophantine Equations, Sequences and Series, Limits, Mathematical Induction, Perametric Equations, Polar Coordinance, Complex Numbers, Vectors, Probability, Elementary Statistics and Elementary Topology.

A number of science teachers were sent on a Refresher Course dealing with the proposed new Grade XIII Physics Course. All fees were paid by the Board of Education. Another 15 teachers attended a special course for Chemistry sponsored by the University of Toronto. The fee was $75 per teacher and was paid by the Scarborough Board.

As you can see, the stress in this programme was on science and mathematics, but in fact all departments have participated in the programme. The scarcity of trained guidance teachers for example, prompted our Secondary School Superintendents to select potential Guidance teachers to attend Elementary Guidance courses. Again the Board paid the fees. Through these courses, such teachers may proceed towards a Certificate which will change their salary category. However, the urgency and the need for trained Guidance personnel made it essential for us to take action to train the necessary teachers (and who benefits the most, teacher or public, was left for philosophical debate). In the opinion of our Senior Assistant Superintendent of Secondary Schools, Borde Allison, a programme ought to be developed in order that teachers may attend course for one, two or three months during June, July and August, paid by the Scarborough Board. In conjunction with Scarborough College, a most cooperative institution, it would seem that there are no insurmountable barriers to doing just that at an early date. During the month of June, teachers from Teachers' College are likely to be available for supply teaching. There seems to be little doubt that more stress must be placed on the training of Vocational teachers in order that curriculum and practical industrial applications in industry and technology may keep abreast.

In my opinion, most urban trustees are highly sympathetic to the type of programme which Scarborough is developing for its Secondary School teachers. It would seem likely that the improvement in teaching quality and morale is out of proportion to the funds involved.

There are several implications to these remarks which should perhaps be clarified.

First of all, nothing that has been said is contradictory to the stated prime objective of formal education -- the development of the student's skill in the thinking process. No one in this room is so utilitarian to argue that all education ought to be geared to our market economy! But Spherical Trigonometry, differential Calculus, Astro-Physics and the D.N.D. molecule are tuned to our age. Updating, or if you prefer, continuous teacher training, education and research opportunities are the logical parallels to changing curricula in a dynamic society.

Secondly, there is no doubt that a teacher who has been lifted out of his paradoxically lonely environment, be it for only brief periods of time, to explore new or changing concepts, will return to the classroom with a deeper intellectual grasp of his subject and a renewed awareness of the vital part he plays in society. There is correlation between ability to communicate knowledge and thorough grasp of that knowledge by the teacher.

Thirdly, let us talk about money. School Bords with rare exceptions, are disciplined financially by that ridiculously inelastic source of taxation, real estate. In recent years, financial support from Federal and Provincial Governments for education has accelerated, but not nearly as much as the real estate tax. As usual, it is the local School Board which comprehends the needs most and is least equipped to meet them.

On the other hand, one might have some reservations about a nationally financed teacher training or updating programme. If that happened, some fool might devise a formula of such and such a percentage grant for approved courses, and a civil servant operating within the usual inflexible approach for which his political masters must share responsibility, would require a list of approved courses. Pressure would then be exerted to make the courses conform to a more or less rigid pattern, and deletions or additions to the approved list might take several years of negotiation and a ton of useless correspondence. There is no time for such nonsense.

Obviously, the most efficient method is the direct allocation of a portion of personal, corporate sales and other federal and provincial revenues to local education for all purposes, rather than specific programmes. In the parable of the talents, you may recall that funds were advanced on a carte blanche discretionary basis and subsequently the three servants or money managers were called to account for their trusteeship.

By all means, let us call the local authority to account, regularly and frequently, but not necessarily within the narrow terms of reference of those strongholds of inertia, ponderous Cronwellian levelling governments, or uninformative Marley-like auditors' reports.

How about the development of yardsticks to measure the local authorities' effectiveness in serving local educational requirement?

Alas, the urge to conform seems to outweigh the necessity of reform.

I say, go back to your Boards; if they haven't got something like the Scarborough teachers have going for them, work for it. You may be surprised by the response of your Trustees, for once the need has been demonstrated, Trustees will tax for it.